Foundry Sand

ITS USES
and
ABUSES

By

EUGENE W. SMITH

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FOUNDRY SAND

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The Home of the Vibratory Test

INTRODUCTION

THE only plausible reason which may be offered for the production of this book is that it may prove the opening up of a new path for the scientist who cares to travel it, in trying to surmount that seemingly insurmountable and costly pile of scrap which is produced in the foundries of our country each day.

When the products of nature are used contrary to the natural laws of nature, only detrimental results may follow.

In the study of sand and its uses, the writer has tried to conform to nature's laws.

Each defective casting is only an effect, caused by deviating from the natural course because the way seems easier.

The future may see the way which now seems so winding straightened out into a straight road to successful foundry practice and costly waste of material, labor and money wiped out.

In its production the author has endeavored, as far as possible, to keep it in the language of "A Man in the Foundry" to "The Man of the Foundry."

If it only serves to start us in arriving at a common viewpoint and expressing "Sand Values" in foundry terms, at the same time assisting the man in the shop in "Reducing His Losses"—the producer in being able to "express his product in figures easily understood" by all concerned—the purchaser, the executive and the molder, the author will feel greatly satisfied.

The writer wishes to acknowledge and thank all who have so kindly contributed to the production of this book, by the submission of specimens and general information and who have all expressed themselves as wishing to give the foundryman "what he wants" and "as he wants it"—and, what is more fitting than that their wish should be conveyed to the foundrymen by a foundryman?

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FOUNDRY SAND

Principal Foundry Requirements

THERE are three principal requirements for successful "Foundry Practice," regardless of the size of the foundry or the money invested:

GOOD EQUIPMENT
GOOD METAL
GOOD SAND

These three items cover every possible condition affecting the production of good castings and it will be found that where these three points are covered efficiently, the human element, the molder, who is invariably blamed for all ills which cannot be otherwise accounted for, will also become proficient and willing.

It is noticeable that where a foundry has provided all of the above conditions, the workmen connected are more contented and share in the good results obtained thereby, and attain a reputation as good mechanics outside of their own little circle.

EQUIPMENT

This word covers many things essential to the production of good castings, regardless of the class.

The shop — ventilation — light arrangements — safety appliances—sanitary arrangements—patterns

—tools—coreboxes—machines—handling and melting devices, and all classes of labor-saving devices.

Present-day competition being so keen does not permit the practice of years ago where the writer has seen it necessary for the molder to run all over the shop when he needed a bar for his flask, or tools to work with, which others had in use, requiring him at the same time to use all sorts of ingenious devices to overcome faulty equipment.

It is not the writers' intention to try and cover this field at this time, as every technical association and Foundrymen's Club, as well as Foundry Magazines keep the new methods and appliances constantly before us, and the Annual Foundry Exhibit provides a visible means of obtaining up-to-date equipment.

GOOD METAL

By this title is meant metal suited to the class of work to be cast—Steel, Ferro-Steel, Castiron, Malleable Castiron, Brass, Aluminum and other non-ferrous metals, each being a different form of metal, with a wide range of temperatures.

Fluid metal, with the highest temperature possible consistent with the character of the castings to be poured, is essential to assure a thorough homogenous mixture of the elements.

The ancient topic, *"Ratio of Fuel to Metal Melted"* has caused more foundry losses than any other operation in cupola practice. It is poor economy to save one hundred pounds of fuel and lose one hundred pounds of castings.

If more attention were given to *"Carbon Units in the Fuel"* which are productive of *"Heat units,"* within the required limit below the melting zone, far greater economy and better results would be obtained than by discussing fuel ratio.

This topic, *"Good Metal"* is also one for technical discussions.

GOOD SAND

What is it? How can it be accurately determined? This is probably the most neglected *Foundry Topic,* possibly because it is so little understood.

Geologists tell us but little—they tell us that *Sand* is disintegrated rock, which takes on the characteristics of the rock from which it comes. Disintegrated by the weather—underground and surface streams, washed to lower levels, and deposited where it remains until covered by vegetation and other deposits, retaining in most cases its original mineralogical and chemical forms until again affected by the soil above and later again returned to rock by the earth's pressures.

Some of the sands as washed up out of the earth again by the flow of the rivers are taken up by the winds and deposited and are constantly shifted, forming dunes and hills. In this form the sand has but little *Bond* and is unsuited for the making of molds, but may be useful in the making of cores by adding an artificial binder, which binds the grains together when baked, still leaving a porous condition which allows the gases to escape when surrounded by the molten metal.

"SAND" NATURE'S WAY

Rock, disintegrated by Nature, by the use of water (Rivers, Rain, etc.), deposited by the same power in lower levels, ground finer and finer by constant movement. Divided into two parts, one separable in water, the other retaining the features of the original rock. When finally arriving at a resting place, it is subjected to the workings of nature's laboratory—the rain, sun and chemical deposits.

The two principal elements are iron and aluminum, which in some manner combine with the finer divisions of the sand, forming silicates of iron or alumina.

Alumina is more readily taken up in the fine portion of silica and iron in the heavier portion, thus seeming to form a cement-like liquid binder which acts upon the surfaces of the heavy grains, holding them together.

The Vibratory Method separates this Bond, showing the light and heavy grains and the chemical presence is shown by color. Silicates of iron are *red,* while silicates of alumina are *yellow.* As combined in nature, water is the agent of separation. In the notes above, the presence of iron and alumina is not necessarily the source of the bonding element, and may only be indicative of their presence by the color. Various tests and observations lead the writer to believe that calcite is the basic element. This is worthy of thought by the chemist in sand research.

Back in the dark ages, the founding of metals existed and man used the material most convenient to receive the metal. Rock was hewn out into the shape of some tool or implement of war.

Later, rock in its simpler form — sand or clay, came into use, in passing from one to the other, up to the present age. The artisan as he became more proficient from time to time, made additions to the sand of foreign materials, as binders to secure the mold, and openers for the escape of gases.

Step by step, he became more proficient and mainly by word of mouth passed the various tricks of the trade from one generation to the other, until the practice has become one conglomerate mass of makeshifts. Materials used for a specific purpose at the time of their origination have later become a menace through their misapplication and large numbers.

Clays, facings, core-binders of many kinds and grades of material, ground coal, charcoal, minerals, etc., flour and all grades of corn products—resinous extracts from wood pulps, oils, pitch and asphalt binders, molasses, straw and barn products, and where all else failed—nails, rods, gaggers, solders, etc., were added. A great many of the materials mentioned are used only in the making of the cores but have a vital influence on the sand in the heap.

No matter how good the sand used to make the mold may be, or how far it has been brought, or its price, is it any wonder so many good molding sands are condemned after considering that each of the mentioned materials have a direct bearing on the sand used.

SAND IN THE FOUNDRY

The study of sand to be of any use in the foundry must be made in the shop itself and not in the laboratory. He who makes the study must first ascertain all materials, etc., used and study their effect upon the new sand. He cannot do this by squeezing a small portion of the heap into a ball and judging the sand by its "feel." Even if he were able to do this, he could not describe it on paper, where it might be of service to others.

He must familiarize himself with the character of the work to be made, its finish, etc., also with the temperature of the metal necessary to produce good castings, and its effect upon the heat-resisting qualities of the sand.

The man in the foundry when in trouble and unable otherwise to account to his employer for unusual losses which occur, generally resorts to the ever-ready alibi "the sand is no good," seldom, if ever, attributing the losses to mistreatment of the sand.

An instance occurred which the writer has in mind in a larger western foundry where unusual losses occurred periodically in the "pitting" of the surface of the castings. This matter was attributed to the sand, which apparently formed into many minute balls, supposed to be caused by a sand-cutter used, throwing a discredit on one of the best known sands in the country. It was found later that the excess core-binder used and the hard flinty cores in breaking down into small particles below the size of the mesh in the riddles which were used, picked up some of the bond and rolled into small shotlike balls, which when placed against the pattern were exposed to the molten metal and the gases from the core-center caused the pitting effect.

In this instance the laboratory might have shown the presence of the balls or the silica content, but would not have shown the real source of the trouble.

Excess fineness in sand is often occasioned by the use of foreign materials in the making of the core. Similar effects would occur in the use of excess sea-coal or the presence of a large portion of silt in some one of the sands used. The effect of each of these on the casting could be about the same, but very hard to trace to its original source.

Iron fillers, electric welds, burning-in, etc., for defects in castings are no doubt money-savers in cases of emergency, but continuous use of these methods only serve to cause the foundryman to neglect the real source of the defects, which in ninety cases out of one hundred could be traced to some sand condition and when the cause is removed, would remove the waste of labor, time and material required to produce *"patched"* castings.

Chemists have made analysis of sands for many years, showing accurate percentages of Silica, Iron and Alumina oxides, and all of the other chemical contents.

Tabulations have been made and compared, but outside of the analytical knowledge contained, but very little progress has been made in deciding what would be called a standard test for sand, which could be used to replace the old time squeeze and feel method of the foundryman.

Mineralogical studies of the various sand grains have been made, also exhaustive studies of their actions under high temperatures, without any apparent advance towards the desired result of determining what constitutes a good molding sand.

Tests of fineness have also been made by sifting the sands through a series of sieves ranging from 20 mesh to 270 mesh and calculating the average fineness. This method has proven very useful in determining the "finish" of the casting.

Sands are also tested for *Bond* by molding a standard bar of sand and pushing it over the edge of a plate until the weight causes it to break off. The reliability of this form of test and its value is comparative.

Thus it will be seen by the foregoing that a common form of determining what constitutes a good molding sand has not yet been determined.

The average foundryman, manager, purchasing agent, producer and salesman has not acquired a knowledge of chemistry, geology and mineralogy, but there is no question as to the great need of some simple, reliable form of communication with each other in the purchase and sale of molding sand, with the assurance that the selection of the sand is suitable to the varied requirements.

This lack of suitable method led the writer to break away from the usual path and try to find a method of "physical" study of the sand.

Just as the old-time melter, who sorted his irons by the much ridiculed rule of thumb, was superseded by the chemist, so must the present form of selecting molding sand by feel and sound be replaced by something better, sooner or later.

It seems strange that foundrymen pay so little attention to sand conditions in their shops, where the conditions are constantly changing due to the varying classes of castings being made.

The highest priced sand is not always the best sand, and in many cases the highest priced sand might be the cheapest.

To arrive at what constitutes a good sand, each foundryman should first study the character of the work he is to produce and choose that which will wear the longest with the least loss of product.

For instance, on light work, such as carriage and automobile hardware, lockwork, light malleable iron, without cores, a fine open sand with a light bond should be used. Suitable sands for this class of work are probably more plentiful than any other grade in the country.

Starting from Wisconsin, through Central Illinois, Southern Indiana, following the Ohio River on the Kentucky side and on through to Virginia, good fine open sands will be found and in Ohio, in the Sandusky, Zanesville and Southern districts, there are excellent grades. Pennsylvania, too, has some and the "O" grades of Albany sands are so well known that no comment is needed.

Great care should be taken in selecting fine sand that is sufficiently open. If the bond is too great, it closes the permeability of the sand and the retained gases resist the flow of the metal, causing serious losses in mis-run and cold-shut work, and the excess moisture this added bond carries, will create blowed castings. Where the bond is too great in a sand, it will not stand hard ramming or pressing.

For light or medium grades of castings, such as machinery castings made on the bench, and valves or fittings ranging from two inches down and for general malleable castings, use a sand of medium fineness, open and strong.

If sea-coal or other facings are used extensively or an excess of cores are left in the heap, a sand for renewal should be on hand, which is higher in bond.

For heavy machinery, castings, carwork, wheels, drawbars, etc., gear work, both castiron and ferro-steel, a heavy strong and open sand should be used, graded in fineness to suit the finish required in the castings.

For extremely heavy castings, 1,500 lbs. and up, there are extra heavy strong bonded sands of gravel-like nature, in which the bond usually has a sticky, molasses-like feeling and the grain very coarse and open. Such sands are mostly used as a prepared facing—prepared in a pan-mill or grinder, with sea-coal in sufficient quantity to prevent fusion of the sand.

In some cases better results are obtained by spraying the mold with a good grade of plumbago and molasses water, and skin-dried. This usually gives a better finish to the casting but extreme care must be taken to dry sufficiently without burning the mold, or scabby castings occur.

Sometimes for extremely fine brass work suitable for ornamental purposes, fine charcoal is dusted in the mold. For stoveplate, light and heavy facings are used and pattern returned to the mold.

CALCITE, OR CALCIUM CARBONATE

Calcite in nature is an element as common as iron, alumina, sodium or any other element in connection with rock or sand, upon the disintegration of the rock. The very first movement made becomes a grinding action and it is natural to assume that the softer or chalky forms of rock would be the first to give way to this grinding action. The rolling, pounding and grinding is constant with every movement, whether caused by frosts, erosion, volcanic action, earthquakes, the movements of the rivers, winds or tides. Glacial action appears the most powerful in its results.

A visit to the gravel banks or hills at Rockdale, Illinois, may be considered well worth while by the sand student interested in the formation of "bond." Ledges of gravel will be found fifteen to twenty feet deep and one hundred feet long. These ledges are formed of great masses of gravel so tightly tied together by millions of thin, eggshell-like webs of cement, the base of which is *Calcite* and the power of this bond may be imagined when it is known that these ledges resist the most powerful charges of dynamite. The air spaces between these globular forms of gravel seem to act as a cushion and leave only a crumbling action on the surface.

This glacial deposit of gravel is in the heart of the limestone district of Illinois.

How long was this material subjected to glacial action?

Glacial Gravel

What amount of grinding did the material get to reduce it to a viscuous gelatin-like substance, which acted upon these pebbles and rocks like glue, forming thin eggshell webs, which later hardened into a cement of great power?

The comparison of this material and an eggshell is the next step, the base being *Calcite.*

You have no doubt seen oyster shells cemented together. Did it ever occur to you that the base of oyster shell is *Calcite?* The shells being flat, laying in beds, subjected to tidal movements and under pressure, it is reasonable to believe that the grinding action is the means of forming a glue-like material, which later under pressure hardens, cementing them together.

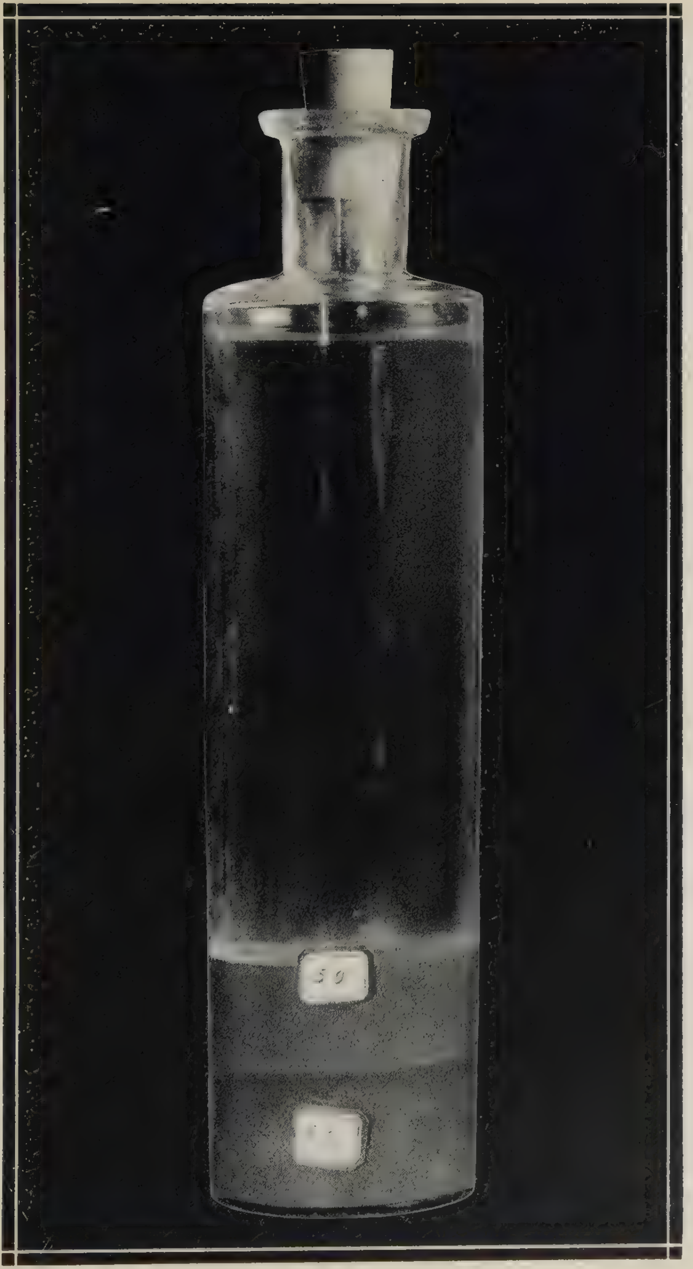
Is it not reasonable to believe that if this action is the result of glacial movement that the same erosive grinding movement by the waters of the earth, which accumulate this fine viscuous substance, later depositing it together with the silica through which it seeps, leaving a coating of cement-like bond around each grain, should be the source of the so-called "bond" in molding sand?

If this sand had not been disturbed by man for foundry uses, before the pressures of the earth became too great, it would have become sand-stone, bound by the same material which had hardened.

Many molding sand pits have been abandoned as having run out, only to be taken up a few years later, after the elements had brought down more of this fine viscuous material and dropped it as a sediment, only to seep through again with the same results.

The man who claimed that we would ever be short of molding sand had not looked into the great works of nature, and what an immense grinding machine he has, which was not built by man.

On the top of one of the hills spoken of at Rockdale, Illinois, is one of the prettiest beds of molding sand one could wish to see. It is not unreasonable to suppose that the floating particles of colloidal material in the receding waters, from the melted ice were deposited last upon the top of these hills, and in the absence of pressures they provided the natural bond for the silicas previously deposited.



Test Bottle—Showing Labels—Ohio Sand

The Vibratory Test

To make a Vibratory Test, prepare the sand sample to be tested by rubbing out all lumps. Use an eight-ounce bottle oil sample type, long style and fill *one-quarter* full of sand. Fill the balance of the bottle with clear water.

Shake the bottle thoroughly for several minutes until satisfied that the grains are washed free of clay, then place the bottle and contents on any form of vibrator, holding it firmly against the vibrator.

If fine sands are to be tested, place a pad under the bottle as a cushion and vibrate the specimen longer.

Invariably when the test is nearly complete, a sharp line or ring of silt or other fine material will form between the silica deposit and the bond or clay above.

When the separation is complete, close observation of the grain sizes should be made.

Next, the manner in which the clay bond settles down will be found indicative of its strength.

Weak, cloudy sands settle very quickly. Strong bonds settle heavily and comparatively slow.

When the specimen has become completely settled, usually in about twelve hours, calculate the percentage of bond and silica as separable by water as follows:

First, measure the total height of the material in the bottle, using a rule having the inches divided into tenths. This simplifies calculations.

Second, measure the silica content which should include the fines or silt in the ring.

Divide the silica measurement by the total. This gives the percentage of silica. Subtract the result from one hundred per cent, which will give the percentage of bonding material.

For comparative purposes the specimens should be marked by small labels on the bottle, placed just above and below the parting line as shown.

Where it is difficult to discern the parting, as in testing black sands, red ink will be found as a useful marker on the bottle at the line of demarcation.

In making the test observe the variations of grain sizes as separated and presence of silt or excess fineness.

Variations in color, if shown, are indications of the different oxides present in new sands.

Slow thick settling, fatty or similar to melted butter, indicates strength of bond.

Fast, thin settling, light and flaky in character, with the water cloudy or dirty-looking, is indicative of weak bond and excess fineness.

Fire-clays may also be tested in the same manner, showing the variations in fineness of grinding, and if the specimen is allowed to stand for a week or ten days, the presence of iron, if any, will be shown in the water.

The best fire clays usually show free and clear.

The fineness of fire clay needed would depend upon the purpose for which it is used.

Three Grades from the Same Deposit

Tripolis, diatomaceous clays, parting materials, etc., may also be examined by the Vibratory Test.

Many other very interesting studies are evolved which could not be produced in any other way.

The method provides a very valuable feature in the fact that the tests may be made by and the full control of the sands placed in the hands of each assistant foreman, and the increase or decrease of the additions of new sands in their own hands, as required by the class of work which they are to produce.

They can also consult each other in common terms, expressed by figures.

It provides a simple means by which the Foundry Superintendent may instruct his assistants as to changes he might desire, based upon his observation of the daily losses.

It is essential that they all work in harmony in the operation of the tests, in recording the changes made and the results, *otherwise the method is worthless.*

DAILY APPLICATION OF THE VIBRATORY TEST AND NECESSARY OBSERVATIONS

Conditions in all foundries differ somewhat due to the grades of sand being used and the class of work to be made. The one in direct charge is the only one who can determine the figures to be used of bond and silica required and to determine this, he must be guided by his daily losses.

He must also closely observe all changes, which occur in his molding operations, which might offset his measurement. This will be explained later on.

He should be provided with the following necessary equipment:

A simple wall rack, which will hold six clear glass, 8-oz. bottles, 8 inches deep, such as are used for oil samples.

A rule divided into tenths.

Any form of vibrator molding machine. If he has no vibrator machine, any vibrator used for facial work or other purposes will do.

In selecting his sample he should take it from some place which represents his greatest turnover each day.

Care must be taken to avoid too large a portion of sand in the bottle. One-fourth full is always sufficient.

After vibrating, the sample should be allowed to settle completely before measuring.

A curve may be taken showing the change in the bond each day, by providing a square ruled or quadrilled paper with forty to fifty spaces, beginning with 50 at the center, increasing upward by twos and decreasing downward by twos. The days of the week should be placed in the squares across the top.

To ascertain the proper point, the figures denoting the *Bond* each day should be watched until they tally with the best average percentage of losses.

These percentages should be posted at the bottom of the sheet in each square and the corresponding date at the top of the sheet.

If a medium grade of sand is used, the bond and silica, say 50/50 should be designated by a dotted line (red ink) across the page and the foreman in charge of the sand should aim to control the curve shown by the addition or detraction of new sand in the heaps or system.

Many little things occur in making these records, which may affect the curve, but must not be ignored. For instance, if a number of molders are not working, there would be less sand in circulation and if the same quantity of new sand were used, the bond would increase. Likewise, if the new sand was left out for several days, the sand would weaken and the curve would show both conditions.

Ordinarily the foundryman does not discover that his sand conditions have been changed until losses have occurred which compel him to increase or decrease the new sand in his heaps.

This is the main advantage of the application of the test. It tells him each day if changes are necessary and if carefully watched, the changes of one day balances the next.

The racks should be placed in as conspicuous a place as possible in order to attract the attention of everyone concerned to the fact that a record is being kept. *Good light* is essential.

The best way is to place the contents in the bottle each evening, allowing it to settle over night, and then take off the figures in the morning.

Even if the actual test each day were not of any immediate value, the psychological effect upon everyone concerned would be of incalculable value, due to the fact that an interest is being taken in that much-neglected division of foundry practice.

Where there are different foundry divisions and different grades of castings made under the direction of different assistants, a test rack should be placed in the charge of each.

This procedure will have a good effect upon everyone concerned, educating them to the fact that good sand conditions are necessary, if *better finish* and *reduced scrap losses* are desired.

Plate No. 4 shows an interesting experiment which was made in an effort to find out what would be the "sensible bond" figure at which to maintain a certain chart.

It was assumed that the sand should be about 70% Silica, and 30% bond and red lines were drawn through these figures.

When tests were made it was found that the sand tested 60% Silica, and 40% bond, with a very low scrap loss.

As the bond was gradually decreased to meet the 30% line, the scrap automatically increased. This proved that the "sensible bond" figure was at 40% instead of 30% and the red lines were changed from 70% Silica, and 30% bond to 60% Silica, and 40% bond.

RECORD SAND CHARTS

The use of graph record sheets for three full years has proven that it is possible to *control the bond* in the molding sand while in use.

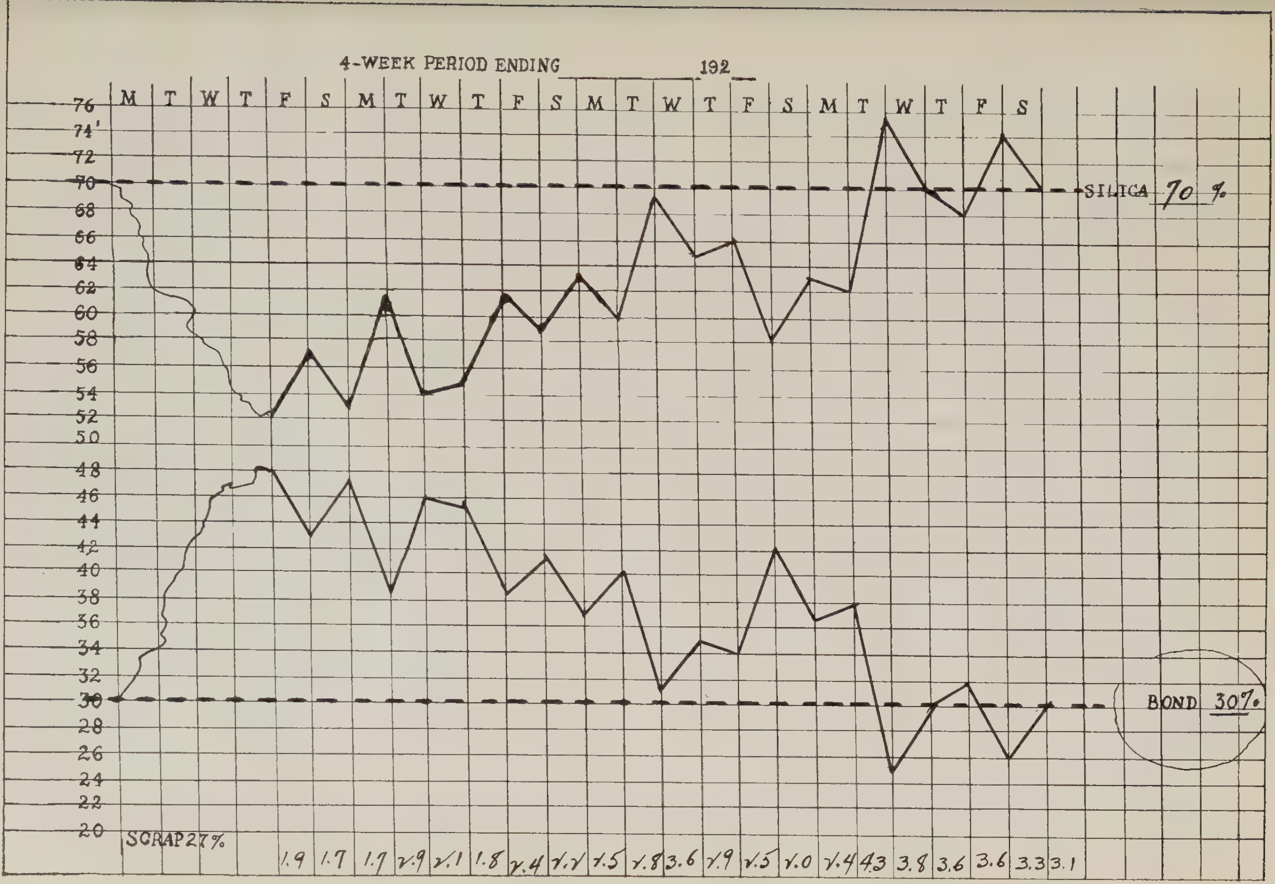


Plate No. 4—Specimen Chart

Four different mixtures or blends were required. For light castings, medium light castings, medium heavy castings and heavy castings.

For the light castings, a sand very fine in grain was used. The bond was controlled by additions to, or decrease of the use of an extremely strong bond sand.

For the medium light castings a medium even grained sand was used to retain the finish of the castings. The increase or decrease of bond in this sand was balanced by the use of the strong bond sand as indicated necessary by the graph each day. *No fine sands used.*

The medium heavy castings were made in the same sand as the medium light castings with an occasional addition of a heavier grained sand which served two purposes. First, on account of the heavier grain it provided excellent venting qualities. It also provided better wearing conditions. The strong bond sand was used as before, all changes being guided by the daily tests and graph.

For heavy work, the medium grained sand was still used as a standard, but a strong, heavy-grained sea-coal facing which was mixed in measured quantities, and thoroughly mulled, riddled and disintegrated was used on all patterns which were liberally covered at all times with this well tempered material at least two inches deep.

The condition of this material may be realized by considering that no venting, no sponging or swabbing, no gaggers or soldiers, no bars in the flasks, etc., are required and the molds are pressed or rammed extremely hard. Losses from blow or boiling molds are practically nothing.

Occasionally castings are made weighing one thousand pounds to eighteen hundred pounds. The same facings are used with an extra 25 pounds of heavy grained sand added to the mixture for venting purposes.

In the use of the chart it is surprising how close to a given figure the different grades may be kept.

A variation in the bond of 4% above or 4% below the "sensible bond figure" will not cause loss. Go over 4% high in bond and the usual loss caused by too strong sand will occur. Go under 4% low in bond and the usual loss caused by weak sand will occur.

Occasional radical changes or jumps in the graph up to a high point and back just as suddenly, only indicate error in the specimen selected or an improper manipulation of the test. Such changes seldom occur over two days in any month and do not affect the losses. Where the changes like this occur for several days consecutively, they must not be ignored, as they will be plainly indicated in your daily scrap record, and the bond must be increased or decreased as called for by the graph.

In the use of the Vibratory Test the foreman or assistant in charge of each division of the foundry, should be in charge of all changes made and these changes should be made only to suit his version of the conditions best suited to the class of work which is made in this particular division. In other words, his hands should not be tied.

He selects his own specimens, makes his own tests and guides himself by them.

When he makes the test he places the specimen in the daily rack to settle over night. The scrap clerk or someone assigned to do so, should take the specimens from the rack on the following morning and measure the bond and silica of each sample and after marking the labels and putting them on the bottles, showing the percentages of bond and silica, he should record these figures on the graphs of each foundry division and replace the bottles in their respective places.

To have the tests effective and the graphs of full value it is absolutely necessary that the entire foundry personnel must be perfectly in accord and work together to reduce losses, no matter what the cause.

One foundry alone has made a reduction in its losses 43.8% in three years—from 5.7% to 2.5%, the reduction being entirely due to bond control and the study of various defects caused by sand conditions.

All of the foregoing on control is ideally adapted to continuous sand systems, where all the sand is handled by machinery. A great many foundries are using the Vibratory Test under slightly different conditions with remarkable success.

Where a foundry has upwards of one hundred heaps, they are classified into as few groups as possible, taking into consideration all heaps having the same approximate metal weight, metal thickness and cores.

A bottle is provided for each of these groups and a test made at regular intervals which can be stretched out over longer periods of time as the sand is brought under control.

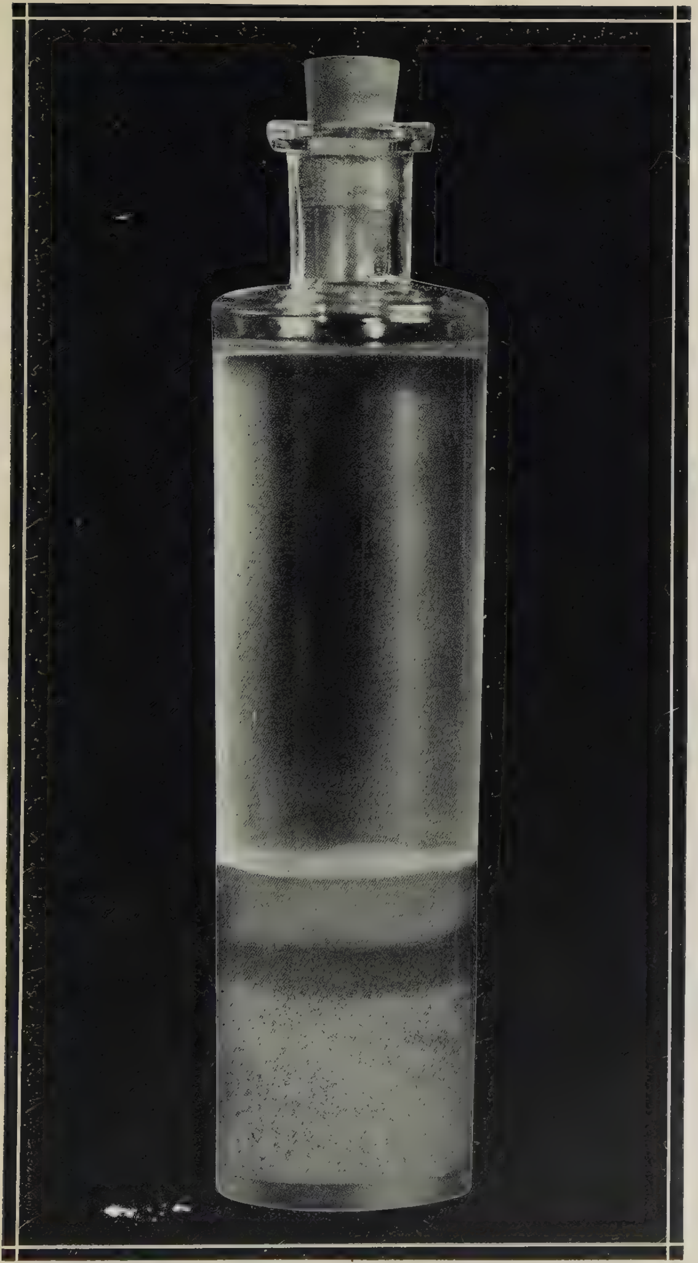
For these groups a tray is provided having numbered compartments to correspond with the numbered groups.

Samples are then taken from each heap in each group and thoroughly mixed, from which a sample is taken for testing.

In foundries where men are working piece work, this offers a means of communication between the molder and foremen where trouble arises on work to be discounted. When a question arises as to the sand being at fault, a test settles this to the satisfaction of both.

The thought is generally overlooked that castings which have been scrapped have cost the foundry money and if the heap sand can be kept right, both the molder and foundry owner save money.

It has been found through tests that a big heavy set man rams a mold harder than a small frail man. If a heap is carrying a percentage of bond suited to the ramming of the small man, it is unfair to ask the heavy set man to work this same heap, as his harder ramming would cause blows and scabs. In order to get good castings he must hold himself in check and not ram so hard. This puts him under a strain and it is impossible for him to turn out a full day's work under this strain. Asking a man to ram light, is as hard on him as to ask him to ram harder. How much



This Specimen Shows an Excess of Silt or Fines

better it would be to provide this man with a heap of sand ideally adapted to him, enabling him to work in his free and easy natural way, without a mental strain of any kind.

A stove plate foundry has carried this a step farther, and has provided a card index system for every man in their employ. It is granted that stove plate, firepots and furnace castings each require a different sand. For example, when John Jones is working on stove plate work in this shop, his heap contains so much bond and so much silica. When he is working on firepot work, he requires bond so much and silica so much and on furnace work, bond so much and silica so much. If today he is working on stove plate work and tomorrow he starts on firepot work, his firepot heap will contain the percentage of bond ideally suited to John Jones.

This same foundry uses no moisture test, but through the introduction of their moisture, they are able to control the *bond* content of the heaps. Before their moisture is added to the sand the heap is furrowed or ditched and the bulk of moisture is applied here. If they are desirous of reducing the bond content of a heap, the heap is *not* furrowed and the water is applied with force. This tends to wash the bond from the silica grains out into the gangway. By actual tests heaps have been reduced as high as ten per cent in bond by this method.

It is also good practice to take heaps of low bond content and add to high bonded heaps to reduce the bond and add sand from high bonded heaps to heaps of low bond in order to strengthen them.

INTERPRETING THE VIBRATORY TEST

The Vibratory Test or any other test of molding sand, either physical or chemical may be made from time to time, very methodically and still tell the foundryman absolutely nothing. A test may be made and figures derived therefrom and these figures tabulated as a part of the daily routine and the heap sand involved go on from day to day without receiving the benefits of the tests made, through the inability of the one making them to adapt the figures representing the test to practical use in the foundry.

The Vibratory Test does not tell what to do to the heaps—it only gives an opportunity to study the condition of the heaps. It follows, therefore, that a heap of sand will benefit only to the extent of the amount of study put to the sample of sand while testing.

A heap sand sample may show by the Vibratory Test to have 35% bond and 65% silica. The silica portion may be studied as to grain size, looking both for pieces of core sand and shot, also excessive coarseness near the bottom and excess fineness near the top of the silica portion. In studying the bond portion, this 35% bond may be entirely out of line with results in the foundry. There may be scrap due to dirty castings, cutting at the gates, washing or spongy metal at the gates. This would indicate that the test is wrong by showing a strong bonded sand, where in reality the sand is weak. The bond portion of the sample test will show this condition in the manner in which it settles. If, when it has settled about half way down, the bottle is tipped slightly, it shows the bond to be of an ash nature, the bond is weak, whereas a 35% of bond of high colloidal value when half way down would show itself to be fatty and creamy. This ashy condition can be further seen when the bond portion has entirely settled. If the bond is weak, it will be seen that after twelve hours settling the bond is not firm as in the case of a high bonding quality in a new sand. A high colloidal bond should remain firm after twelve hours settling. By tipping the bottle slightly to one side the amount of bond that washes to the side of the bottle will indicate the amount of ashy material in the bond.

It further follows then that if a test of heap sand has been made and the bond portion falls abnormally fast and after twelve hours measures 35% bond and on tipping gently shows a tendency to wash, this heap must be weak or "rotten" and steps should be taken to correct this condition. If the figure of 35% bond is assumed as right, without any study, trouble is sure to follow.

In the examination of the bond portion, burned sea-coal will be found in a steely black layer on top of the bond. This portion will wash off leaving the bond portion when tipped, further indicating it to be burned sea-coal. The fact that it is so easily agitated with the slightest movement of the water proves it to be a matter entirely foreign to bond. It has absolutely no stickiness or plasticity to it—it is just plain ash which means that in the heap and mold, it will take bond to hold it in place.

If a heap shows 35% bond and in reality has 15 or 20% bond, this bond is barely sufficient to carry the silica grains and means dirt in the mold just as soon as metal comes in contact with it. We are not interested in the total amount of sea-coal in the heaps, but we are vitally interested in knowing whether or not we are using too much sea-coal. The excess sea-coal can be seen floating on top of the water in the test. This is simply live carbon and therefore floats. As soon as it has burned to an ash it will settle on top of the bond portion. As there is no bonding quality to live sea-coal or its ash, it is necessary to have sufficient bond to carry this, too. The bond in a good sand cannot do double duty, viz., carry the excess sea-coal and strengthen the sand at the same time.

When facings are made a small amount of heap sand is mixed with new sand and sea-coal. When the mold is poured, the only sea-coal to burn off is that which comes in contact with the metal. The balance remains intact and enters the heap when the castings are shaken out. From this point on it is known as excess sea-coal as a very small portion will ever get back into the facing. When a test of the sand is made the sample is taken from the heap; therefore, all sea-coal found floating on top of water is excess sea-coal, today, tomorrow and a year from tomorrow, as long as the same mixture is added. When the amount of sea-coal floating in the test is too great in proportion to the size of sample tested, it is a very safe and sane procedure to reduce the amount of sea-coal in the facing until this condition is remedied in the heap.

EXCESS CORE SAND

The foundrymen who use a white silica as a core sand will have no difficulty in telling when their heaps are getting excess core sand in shaking out. The white silica when burned by the iron discolors to a steel gray and will divide itself into a distinct layer between the silica of the molding sand and the bond portion. Where a bank core sand is used, it burns to about the same color as the molding sand due to the iron present.

VALUE OF NEW BOND

Many sands will test high in bond when new, but after using once or twice show extremely low in bond. This would indicate one of two things—a very low colloidal quality or excess core sand entering the heaps. This can be ascertained by running a test on a floor with no cores. If the bond continues to weaken rapidly it would show an overabundance of organic matter which burns off as soon as the metal strikes it. This is an undesirable and expensive feature in any sand. It is undesirable because of the gas generated by the burning off of the large amount of organic matter, which gas must escape or cause blowing and expense due to the amount of bond which must be burned off before the sand is fit for use. If a sand tests 40% bond, when new, and tests

25 or 30% when in working condition, it means that 10 to 15% of the carload of sand is waste which must be burned off before giving results.

In testing heap sand, the operator must exercise extreme patience and avoid jumping at conclusions. Each division shown (sometimes there are three or four) must be satisfactorily accounted for.

Silica sand—regular molding sand, bond, silt, excess sea-coal or charcoal used, should show in definite amounts. When these elements are all present the vibration used must be very light and of longer duration to obtain satisfactory divisions.

No matter how light the material used, it will show its division if properly vibrated. In the case of extremely light materials, sometimes thirty-six hours are necessary for the water to become clear.

Extreme care should be taken to mark each division properly before trying to calculate the proportions.

A common pen with red ink is the easiest form of marking divisions on the bottle. Sunlight is the best for observation.

All variations in grain size and color as shown should be accounted for.

If your study of sand is carefully carried out, as described, it will be found to be most fascinating.

If fine sand is vibrated too hard the finer portion of the silica is held in suspension with the bond, later settling with the bond as a part of it.

Fine sand, shaken up until foamy and full of bubbles should be allowed to settle a little to allow air to rise as a peculiar action takes place—the air bubbles appear to come down with the bond while vibrating, which if allowed to get down to the silica, carries the bond with it, and by the pressure of the silica, flattens out around the sides of the bottles, discoloring the silica.

Specimens which have been separated, if allowed to stand in the sun, sometimes show green formations, also gases form, which in rising, form small tent-like masses, filled with gas, which later escapes in a bubble to the top, similar to the action of an old stagnant pond. This indicates the presence of humous matter.

Many strange actions and colorings take place at times, which if unaccounted for, a new trial of the specimen should be made.

Silica sands invariably darken after separations, which at first are a pure white. Sometimes they blacken in comparatively wide bands, probably indicating an iron-oxidation.

Mica-schist takes on peculiar actions—sometimes flattening out around the glass like particles of gold (this is possibly sulphide of iron) and again, separating in light silvery bands at the partings, between the silica and the bond, the latter invariably when the silica divides into two grades of fineness.

Frequently in testing foundry sands, where more than one grade is used, the *silica* will divide in two parts, coarse and fine.

Where cores are used excessively, the core sand is very noticeable as a gray section at the top of the silica.

Many new sands show two grades of fineness. This is not a good feature as the finer particles undoubtedly act as a filler between the spaces of the coarser sand.

MOISTURE TESTS

So much stress has been laid upon the effects of moisture in the sand and so many methods tried for testing the moisture content of the sand, that it is time we stopped to consider of what real value they are to the molder.

In the past he has always placed his hand, palm-side down in the sand and closing it with a firm grip, he then turned his hand over and opened it, allowing the ball formed to roll forward on his hand. This brought the edge of the ball to the top. If the edge or line formed, held, showing sharp and clean, he was satisfied there was moisture and bond enough to make a perfect mold. If the edge was blunt and rough, and the ball crumbled in his hand, he was satisfied it was too dry or too weak. If it had a velvety smooth feeling, he was satisfied that his casting would have a suitable finish and proceeded to make his mold.

Experience has shown that in making this test he has always been unusually accurate. He knew when the sand was fine of grain or coarse by his sense of feel. He could also determine the strength or weakness and invariably proceeded to provide remedies to his own satisfaction. The only drawback to his method was that he could not impart his knowledge to others, as there was no set rule for it and this accuracy could only be acquired by experience.

During the introduction of the squeezer and other forms of molding machines and the added element of "inexperienced help" the sand conditions became less subject to control and created added losses from blowed work and other defects caused by improper sand conditions. The frequent repetitions of these losses and the ever-ready excuses (wet sand—sand no good, etc.), pointed to the necessity of a remedy and the result has been the origination of a number of laboratory tests. The actual value of these, as far as the molder is concerned, is as yet undetermined. Theorists may make claims, but nothing tangible in the saving of loss has yet been offered.

Regardless of all that has been offered, the man in the foundry who *knows,* is slow to give up his own judgment and continues to dig his fist into the sand, the old way and would not care to discontinue the old practice. Even he who makes moisture determinations mechanically also digs into the sand to prove the correctness of his conclusions.

COLLOIDS

The word "colloid" is derived from a Greek word meaning glue or glue-like and plays a very important part in the life of molding sand. Dr. Arndt in his book, "The Colloids in the Industrial Arts," states "Unlike past impressions, it has been found that the word 'Colloid' does not signify a class, but signifies a state of being to which anything, organic, mineral, or crystalline may be brought." However, he states further, "Some compositions have one substance very finely divided within another. The term 'dispersed' systems has been introduced to designate this composition. The finely divided portion is termed 'Dispersed phase' and the other 'Dispersing medium'."

A very practical picture of how these two component parts differ can be had by comparing a sample of sand bond in suspension with an ink or a dye. The sand bonds are called "suspensions" or aggregated dispersed systems and the ink or dyes are called true solutions or molecular dispersed systems.

A very simple test demonstrating the difference between suspensions and true solutions is to make a Vibratory Test with ink or dye in place of clear water. The suspension or bond will separate itself from the true solution by sedimentation and leave the ink or dye in suspension as a true solution. This can be further shaken up thoroughly and filtered and the slime or finer molecules of the bond will remain on the filter paper, whereas all of the true solution will pass through the paper smoothly.

But, where does this enter into sand? In a Vibratory Test it has been noticed that a bond which while in suspension appeared flaky was invariably short-lived. It naturally follows that the bond which appears flaky has too little of the dispersing medium in it. The writer feels that the ideal sand consists of a bond having an evenly proportioned amount of "Dispersed phase" and "Dispersing medium."

Riverside, California

Dr. Arndt also tells us that the more finely this suspended mass is divided, the more area of glue-like matter there is and the more colloidal the substance, whereas with a lack of dispersing medium, these minute particles have a tendency to adhere to each other and build up, giving the aforementioned flaky substance, which by observation can be seen to contain much less glue-like area than a finely divided substance.

This in itself, a simple observation of the Vibratory Test, should prove valuable to the foundryman when about to purchase molding sand.

*WHAT IS A COLLOIDAL CLAY?

A colloidal clay is a clay which contains particles of such a size (.002mm to .0001mm) that when mixed with water, the resulting mixture shows the properties of a colloidal solution. That is, the particles more or less stay in suspension and do not settle out. There are two general classes of colloidal solutions, one of which has a viscosity of about that of water as is well represented by ink, and the other which has a consistency nicely illustrated by starch. A colloidal solution consisting of a mixture of clay and water is not especially viscous, but is very adaptable to use in slips.

Science attributes the property of these particles to stay in suspension to a movement, comparable to atomic movement, made possible by the extremely small size of the particles. This is commonly referred to as Brownian movement.

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*Above is from recent Trade Magazine article.

*BENTONITE

This mineral, or rather group of minerals, has proven valuable principally through its colloidal and absorptive powers. Referring to the typical mineral, it ranges in color from white through the yellows, pinks, browns to black. It is exceedingly fine grained and has a waxy or soapy feel and appearance. It is highly absorbent, being capable of absorbing three times the weight or seven times its volume of water.

The type varieties have remarkable colloidal properties and when finely ground will remain in suspension indefinitely:

†*Analyses.*

Silica	57.96	63.20	55.22
Alumina	22.46	12.90	21.00
Ferric Oxide	3.80	2.46	3.61
Titania	...	.11	....
Lime	1.92	.82	4.94
Magnesia	3.24	2.09	3.04
Alkalies	1.25	.92	1.56
Sulphur Trioxide	.75	....	.43
Ignition	7.93	3.70	....
Water	...	13.80	10.28
TOTALS	99.43	100.00	100.00

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*Above is from recent Trade Magazine article.

†Analyses from Bureau of Mines, Serial No. 2269, R. B. Ladoc.

Occurrence

The type mineral occurs in Wyoming, the name *Bentonite* being derived from the geological formation in which it occurs. In this State the deposits are large and outcrop over a wide area. The principal workings are located in the Laramie and Big Horn Basins. Deposits also occur in California, New Mexico, Arizona, Utah, Montana, Idaho, South Dakota, Texas, Tennessee and Indiana. Both the California and South Dakota deposits as well as those of Wyoming are worked to a considerable extent.

Uses

Bentonite is probably best known through its use as the base in the medical dressing known as "antiphlogistine." In the ceramic industries it is used as a retarder in gypsum wall plaster and in cold setting refractory cements. In refractory cements its high plasticity increases workability where high percentages of non-plastics are used and due to its superior adhesive qualities, gives them the ability to hold firmly to old or new brickwork.

It has also been used in ceramic processes where an increase in colloidal matter is desired. Other uses are in soaps, where it tends to increase the lathering qualities and as a water softener.

Prof. Paul E. Cox of Iowa State University Ceramic School, has successfully used *Bentonite* to increase the plasticity of pottery clays.

Advantages are taken of its absorptive properties in the paper industry where it is used to take up the ink in reworked newsprint.

SAND CONSERVATION *vs.* SAND RECLAMATION!

A great deal has been said about sand reclamation. Unless the cores and the molds are both made from the same grade of sand it does not seem proper or profitable to spend money and labor to reclaim core sand which is much less expensive than molding sand.

Why not "lock the barn door" by beginning at the source? Stop the *Waste!* Sand, like foundry lumber, if not used judiciously, is a source of continual expense.

Select the best possible sand suited to your own class of work and then take care of it. Use only amounts actually required to keep the molding sand in good condition by replacing the bond which has been lost by fusion to the casting, or weakened by excess core sand or sea-coal.

Large quantities of new sand added to the heap at one time and at widely varying periods are decidedly wasteful.

New sand should be delivered to the heaps in small quantities and as near continuously as possible.

The full benefit of the bond in the new sand would be had if the new sand were first dried, not burned, then crushed and riddled before adding to the heap. When the castings are picked out, the molding sand should be removed thoroughly from the casting and returned to the heap.

Clean floors and gangways mean a great saving of sand. Dry molding sand does not signify bad sand and should always be tempered and returned to the heaps.

Sand which has been dried out for forty-eight hours cannot be tempered in a few minutes.

Pouring of surplus or waste metal in the sand heap is more destructive than the regular casting process.

Permitting hot castings to remain in the sand heap after the mold is dumped is not good foundry practice and injurious to the sand.

When the castings piled on the floor are removed from the foundry, the dry sand remaining should be re-tempered and returned to the heaps, unless excessive core sand has been mixed with it.

Small amounts of core sand are not necessarily harmful but rather serve to keep the heap open.

It would be a serious mistake to overdo the saving of new sand and allow the sand to become weak, causing the loss of castings.

LOSSES DUE TO IMPROPER SAND CONDITIONS

Sand which is too strong or too wet will cause blow, slag, scab, coldshut, misrun and hard iron where light castings are made.

Sand which is too weak or too dry will cause rough surfaces, washed runners, strained, runouts, drop and scab.

Sand which is too fine will cause rough finish, washed-away, streaked or wormy, blow, coldshut and losses at test pumps.

Excess sea-coal will cause dirty surface, scab, pitted, coldshut and show defects after molding.

The ultimate result of selecting the sands best suited to the class of work to be made and using them in proper quantities, at the same time reducing the source of waste, in the foundry, should be increased product, better finish, reduced losses and less waste of metal, while in machining the result should be saving of tools, economy in finishing, softer metals and an improved product.

SILICA IN SANDS AND CLAY

All sands are composed of silica combined with other elements, principally existing in the rock from which they come.

The chemical analysis determines the entire amount of silica both in the binder and the sand combined.

That portion of the silica which combines with other elements, iron, alumina, etc., forming a fine cement-like mixture which binds each grain and is separable by water, is separated by the vibratory process and held in suspension, while that which is not separable by water remains combined with the other elements and is precipitated.

This would naturally cause a variation between the results as given in the Physical test and the Chemical test.

The latter would give the accurate amount of silica in the entire sample, but the former would be equally as accurate in determining the proportion of bond as compared with the sand or silica precipitated by vibration.

The results given would be found amply sufficient for comparisons in determining the characteristics of any grade of sand and its suitability to the class of castings to be made.

The results of the vibratory method show a visible separation by which the bond, the porosity, the fineness of the sand may be told, and its predominant binder, iron oxide (red) or aluminum oxide (yellow) may be told by color.

The simplicity of the method is its best feature—clear water, a clear suitable bottle, a well washed sample and a little vibration is all that is required.

The Chemical Analysis is of great value in determining those elements in the sand which might be objectionable and injurious to the metal.

Fine sands for light work should show high silica and low bond, for example, 75% silica and 25% bond.

Medium sands, similar to the ordinary No. 2 grade should show about 30% silica and 70% bond, while coarse heavy grain sands should show heavy bond, for example, 60% silica and 40% bond.

By comparison of grain sizes, the finish of your casting may be improved in the selection of new sand.

The sieve test may also be used in determining the fineness of the sand in addition to the above.

The foregoing figures only apply when the amount of core-sand dropping into the heaps is light, but if the amount of core-sand dropping into the heaps is excessive, then bond must be added in sufficient quantities to prevent the core-sand from weakening the heap.

A very practical fineness test which can be made in the foundry is to fill an ordinary 100 cc. graduate tube with dry sand to be tested. After shaking thoroughly, place contents of the 20-mesh in a mortar and rub with a wooden pestle to remove all bond. Replace this on the 20-mesh and shake thoroughly. By using a 100 cc. graduate tube of sand the amount of sand on any mesh when placed in the tube, automatically gives the percentage. Starting with 100 cc's of sand it will be noticed that the total after screening is more than 100 cc's. This is due to the separation of the finer silica and bond and a slight tap on the bottom of the graduate tube will bring the total content down to 100 cc.

Add together the weights on the 40-mesh and on the 20-mesh and multiply by 20. Multiply

that on the 60 by 40
that on the 80 by 60
that on the 100 by 80
that on the 150 by 100
that on the pan by 150

Total these amounts and divide by 100. This gives the average fineness of the sand.

NOTE: In many instances the sand is washed free from clay and then dried. The writer prefers the test without washing as it is more in keeping with the sand as introduced into the heap.

ILLUSTRATION OF THE FOREGOING FIGURES FOR FINENESS TEST

Left on 20-mesh...........	.9 grams	
Left on 40-mesh...........	6.9 grams	156.0
Left on 60-mesh...........	21.2 grams	848.0
Left on 80-mesh...........	19.8 grams	1188.0
Left on 100-mesh...........	13.8 grams	1104.0
Passed through 100-mesh....	37.4 grams	3740.0
	100.0 grams	7036.0

7036.0 divided by 100.0 equals 70.3 fineness.

USE OF SAND

To realize the importance of having the foundry sand in good condition at all times, all that is necessary is to try and enumerate the number of defects in castings, attributable to poor sand.

The finish of a casting should be governed by the relation of the grain size to the temperature of the metal. Sands too coarse result in rough finish. Sands too fine result in streaked, scabbed finish, with streaks showing the flow of the metal, also causing a coldshut appearance where the metal closes in over dust, which is gathered ahead of the flow.

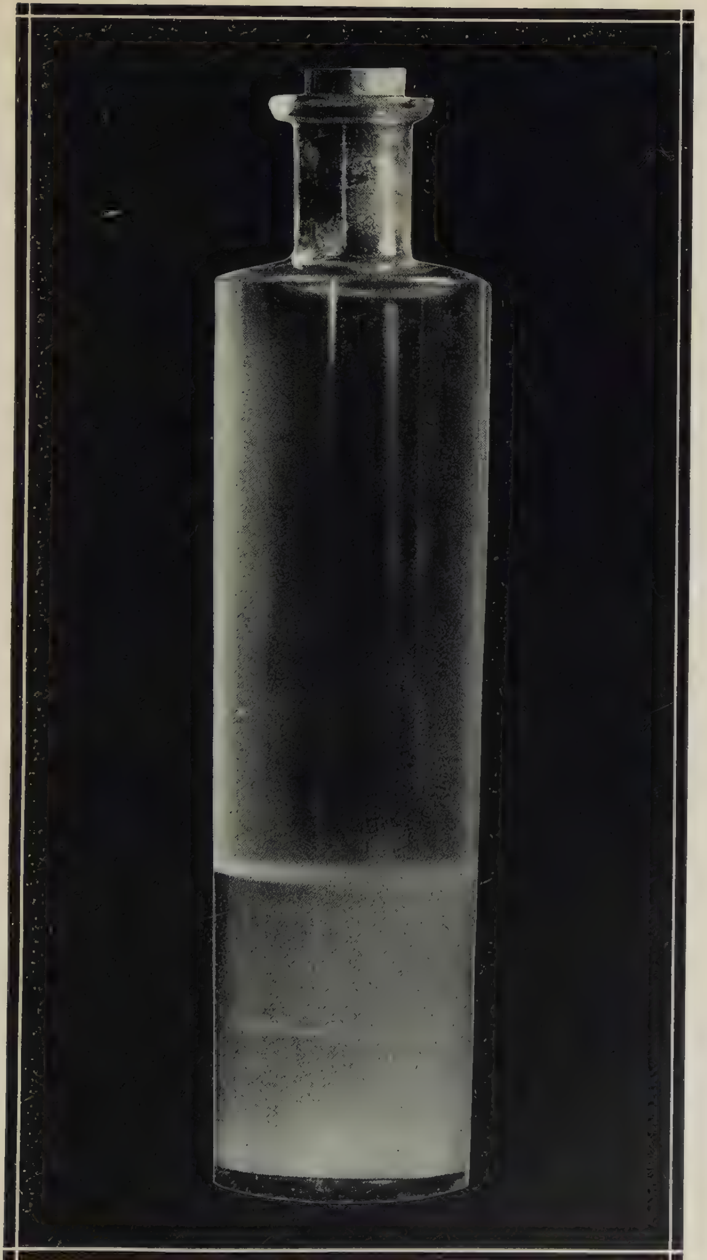
Sands too close or new result in blow, scab, etc., showing a network-like strain where the mold cracks under heat.

Sand too wet causes blow and slaggy castings, the latter condition being due to boiling and oxidation of the metal.

Sand too dry or weak results in run-outs, strain, drop-outs, runners break in.

Fully fifty per cent of all losses in the foundry can be traced to a faulty condition in the sand used, but it must not be assumed that all losses mentioned are due to sand conditions, as in a great many instances the sand is subjected to unfair pouring conditions. *Force* is the most frequent cause of loss which is attributed to the sand. The practice of gating direct into the casting is a poor one, tearing into the mold and subjecting the sand to an unnecessary strain.

The easiest exemplification of *Force* is to consider the flow of water through a hose nozzle entering the



An Illinois Fine Sand

large end in volume, emerging with force. Reverse the nozzle and the result would be volume without force. Another common fault in gating which is unfair to the sand is to carry too much iron through one runner, causing the sand to fuse.

Take a cylindrical casting of small thickness. If the area of the openings cut are compared with what would be cut on the same casting if it were laid out as a flat plate, it would generally be found necessary to double the area of runners.

Overzealousness in saving grinding or chipping is invariably the cause of above conditions, where the gates are furnished with the pattern.

If the foundryman would give the same attention to sand conditions that he does to patterns and metal problems, he would have less losses.

Many a good sand has been condemned on account of unfair treatment.

Sand dried forty-eight hours cannot be tempered in a few minutes.

Sand stored in the open will lose its natural bond.

It is a poor system to measure the quantities of new sand and sea-coal with a shovel in mixing facings. Measuring by box, level full, and standard amounts, will save sea-coal sand and castings.

Sands properly open do away with the necessity of the vent wire saving the patterns.

In the use of fine sands for castiron a very common form of defect occurs. The sand is found fused to the casting and is generally attributed to a sand defect and has the appearance of a scabbed casting.

As a matter of fact, it is caused by too much iron being poured through a single runner. It usually occurs where extremely hot metal is required for light castings of a wide area.

This practice is unfair to the sand. When the sand is fused by the hot metal, a gas is given off and under close observation, if this fused sand is scraped or filed off, small pinholes will be found beneath, which are only disclosed by picking lightly over the surface with a fine pointed tool, which will break through the shell.

The defect is usually a very troublesome one to account for and the metal is blamed for the pinholes and the sand fusing is blamed on the sand being weak.

Sometimes a very accurate casting is required which will not permit machining for finish, a core-box for example, or a core-drier and it is desired that fine sand be used to give a smooth finish. To produce accuracy it is necessary that the sand be rammed hard. This, of course, is productive of blowed castings or rounded edges. Particularly does this apply to our Western sands which are high in bond.

A simple method which will give both fine finish and accuracy is to sieve the sand through a 22-mesh riddle. This allows the sharp or silica sand to pass through the riddle and a portion of the bond to be retained in the riddle, thus permitting the sand to be rammed much firmer without losses.

The writer has applied the foregoing method to a Kentucky sand for over twenty years with excellent results. Sometimes the same conditions apply to a heavy casting.

Another method may be applied—make a prepared facing sand, one-half Kentucky fine sand and one-half ordinary bank sand (new sands). The bank sand acts as an opener for the strong bonded fine sand. The writer has made castings by this method, weighing 125 lbs., but this is not recommended for general practice, as such great care is required to obtain a thoroughly mixed facing.

SAND CONDITIONS WHICH CAUSE LOSS

The average foundryman does not give the same attention to the conditions of the sand, which affect his product, as he should. If his losses become excessive he may give it some attention, but that is only after the loss has been incurred. Then he may probably change his sand or make changes in his methods of tempering it, sometimes purchasing special machinery for the purpose, after which the matter is generally dropped until sometime later when losses occur again.

His metal, patterns, core-boxes and all other equipment receive almost constant attention, also his molding methods, but it seldom occurs to him that the sand conditions cause more loss of castings than any other single item in present-day practice.

Following are some of the conditions which cause loss, assuming all other items are right.

Sand which is weakened by excess silica, core-sand and sea-coal, particularly if it is fine in grain, *Will*—

Cut in front of runners by the force of the metal.
Scab from closeness and hard ramming or pressing
Blow from water present—even if small in quantity.
Drop from weakness or loss of bond.
Cause rough finish by sticking to the pattern.
Cause rough partings when pattern is drawn.
Strain under strong pressures of the metal.
Create coldshut castings by resisting gases not able to escape.

Destroy lines of pattern by packing away, making double impression.

Crush easily if cores are used.

Cause variations in thickness of castings, by sagging mold and wash away in high spots where the flow of metal strikes the cores.

The addition of a suitable amount of bond or new sand and thorough tempering of the sand should remedy all of the foregoing troubles, caused by weak, fine sand. In the addition of this bond, it should always be kept in mind that *fine sand requires less bond than coarse sand.*

Heavy grain sands require harder ramming or pressures than fine sand. The heavier grain sands require greater tempering than the fine sands and much better results are obtained by the use of some form of pan mill or mixer. The heavier grained sands carry greater moisture without harm to the castings.

Care must be taken at all times to avoid excessive use of water. Adding water is not adding bond. Wet sands make slaggy castings, which fact is borne out by the saying, "Pour iron into water and you have a cinder."

When the swab and vent wire disappear from the foundry we shall have perfect molding sands.

The metal is very often blamed for being hard, where an extremely open sand having an excess of moisture has been used and has chilled the metal too quickly. This condition is invariably accompanied by slaggy castings, pinholes, etc., caused by boiling molds.

Very often it is hard to distinguish between castings which are blowed by above conditions and shrinkage. The molder is very often blamed for these losses which are beyond his control and which in reality are caused by the aforementioned conditions. This is particularly true where quantity production and continuous molding is practiced.

SILT

This term is applied to a portion of the silica content as divided into more than two parts by the Vibratory Test, and is usually seen as a small band of extremely fine sand over that which is the representative grain or silica content.

This fine material would undoubtedly fill in between the larger grains and if in excess would destroy the permeability of the sand for escape of gases. Where the danger line would lay has not yet been determined.

This silt or finer material would possibly cause trouble in another direction which also has not yet been thoroughly investigated, that is, in the manufacture of auto cylinders, valves, fittings or other castings, which are subject to high pressures and require tests for leakage.

In the flow of the molten metal into the mold, particularly where force of flow is present, it is very apt to wash out this finer material from between the heavier grains, leaving a fine marking of cut sand showing in the direction of the flow of the metal.

This washed away material, taking the form of a fine dust, would undoubtedly mix with the iron and lodge on the underneath side of the core if used, and in the angles, forming a porous honey-combed mixture of iron and sand, which under ordinary observation of the leakage would be attributed to shrinkage.

The source of this material may occur in several ways, the most likely being where different layers of sand are mined together.

The top layer, after top earth is removed, is generally a fine sand, usually classed as No. 1. The next layer, heavier in grain, is known as No. 2 and the next layer, still heavier, is the No. 3 and it would appear to be very difficult to avoid a portion of the upper layers being shipped with the lower.

Another possible source is where the deposit is covered in places with a windblown dust of extreme fineness. There need be no fear of trouble if this is not in excess. Where silt is in excess the results are that the castings show markings of flow and leakage under test and particularly where the sands are heavy grained and used for mixed facings.

It might possibly be advisable to use a very small quantity of molasses in the water with which this sand is tempered—about a quart of molasses to a barrel of water, just sufficient to barely color the water. Excessive use of molasses would most likely cause trouble and increased cost. The action of this solution would act as a binder to this dust and as the heat of the metal reached it, it would harden, preventing it from getting away.

This third division of the sand could be obtained in no other manner for measurement than the Vibratory Test. It cannot possibly be obtained by merely settling the sand in water. It should not be classed as part of the bond in measurement. It is the *finer silica grain as separable by water.*

Little as is understood of sand by those who are most interested, still less is known of the effects of Silt or excess fineness.

Silt in excess of 15% will destroy permeability and will also cause leaky castings where tests are required. It will show the flow of metal on the surface of the casting and prevent the metal from joining, thus creating a coldshut appearance. This coldshut marking seldom runs entirely through the casting. Silt will also make it extremely difficult to obtain a suitable finish of the casting for plating.

A sand free from silt should leave the hand clean after squeezing and the pattern clean after being withdrawn from the mold. A sand containing silt will adhere to the hand or the pattern and will give the surface of the casting a poor finish.

Conditions directly traceable to silt will be noted in the following:

Weakness in sand; fusion, causing scabbed castings; a destroyed finish; leakage, pinholes and lessened permeability.

The same conditions as traceable to silt are also attributable to the lack of bond and heavy wear in weak fine sands.

PARTING MATERIALS

In bench or floor molding it is necessary to use some form of dry material to separate one-half of the mold from the other. This matter may not seem of importance and is generally overlooked in the study of sand effects in the castings produced, while as a matter of fact, it is one of the most prolific sources of defective castings.

Usually parting materials are purchased without regard to anything but price and the fact that it does not absorb moisture and satisfies the molder.

Lycopodium is probably the most perfect of parting materials, being so exceedingly fine, and as a combustible material, if it is left on the pattern it is consumed immediately by the molten metal, but its price is prohibitive, it being a pollen gathered from plant life. It is only used in fine art work or the casting of precious metals.

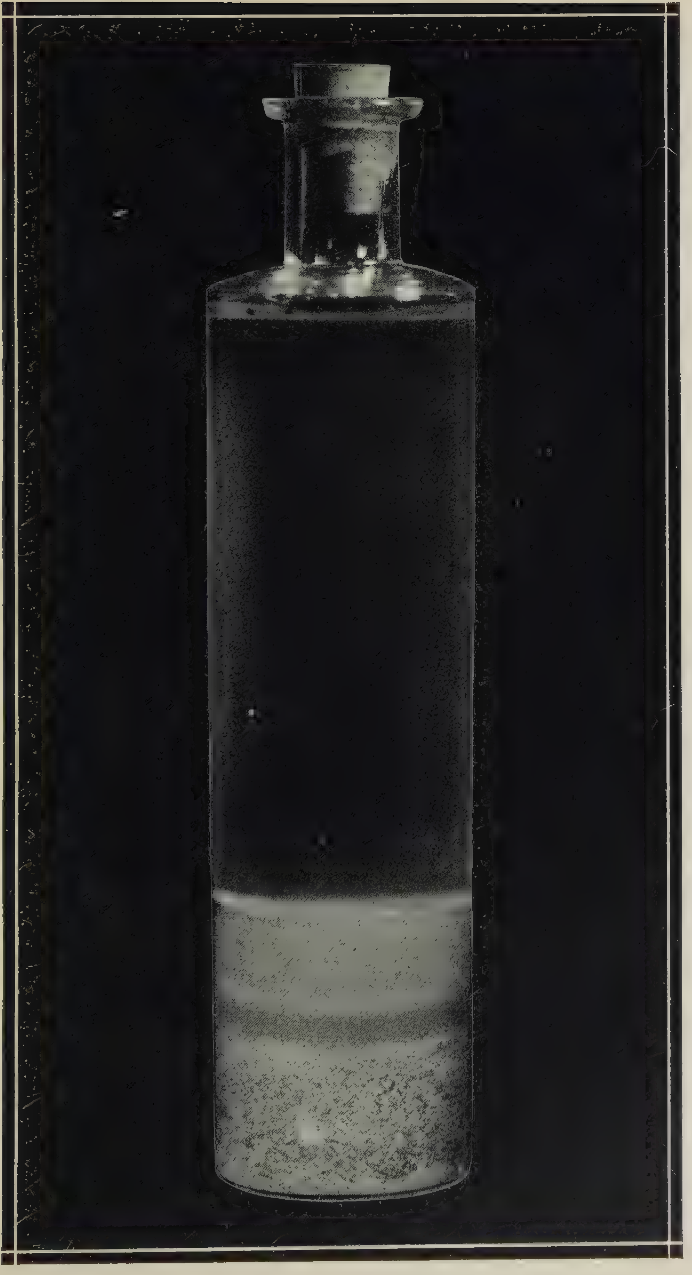
Its use in general foundry work is replaced by the various grades of prepared parting materials, having a combination of vegetable matter and the finer silica sands. The examination of these materials brings out a question as to whether these silicas if used excessively on the pattern will not act the same as any silt, and wash from between the regular molding sand grains and create similar defects in the castings.

This material, through thoughtlessness, is the source of much waste to say the least. Occasional examination of the parting material used in the foundry will make the progressive foundryman think.

Silica sands from the sand blast machines are now commonly used. This is a serious mistake, due to the fact of its exceeding fineness and the presence of large quantities of dirt from the castings. The Vibratory Test will show this clearly.

Previous to the advent of prepared parting materials, the molder usually prepared his own, selecting bank or silica sand of even grain, drying this out in an old pot or box by pouring waste metal into it, then passing it through a fine riddle 22 or 24-mesh if available. This material was of a coarser nature and if left on the patterns caused the castings to be rough. No doubt this was a good thing, as the foreman was always cautioning the molder to blow off his pattern and all loose parting material from the surface of the mold. The grain being heavy usually remained where it dropped and would not wash with the flow of the metal as now happens by use of the finer materials, and the only defect caused was a pitted surface to the metal.

The finer materials not absorbing moisture wherever it dropped into pockets of the pattern or was used in excess, would wash with the flow of the metal, in some cases forming a honeycombed condition of metal and silt, which in any casting that required an air or water test would leak under pressure.



Millville, New Jersey

EFFECT OF FINISH BY FACING

Sea-coal facing (pulverized coal) is most commonly used in proportions of one part coal to ten parts heap sand and up to one part coal to twenty of sand, varying in proportion to the amount of metal in the casting made.

Where this material is continually used, there is always an unconsumed portion of the coal returned to the heap, until sometimes it becomes so saturated with coal that the proportion supposed to be mixed, 1 to 10, really measures 1 to 5, with a proportionate increase of scrap caused by excess sea-coal.

When this condition is present the sand becomes excessive black and soggy, absorbing moisture very easily and the sand is generally classified by the old molder as "rotten."

Concurrent with this condition the increase in scrap shows as slag, coldshut, dirty castings, which when machined show dirty or slag spots and pinholes on the surface.

Sea-coal becomes a weakener of the sand by combining with the bond or clay, preventing a portion of the sand from performing its regular function of binding the silica grains to each other.

Charcoal is sometimes used but is much weaker in action than coal and to obtain the same cleaning action of the sand, twice the quantity must be used. It has no particular effect on the heap.

This material is commonly used in brass for shaking through the dust bag on the mold.

POWDERED ASPHALT has also been used and has a very desirable action, but only one-half the quantity can be used.

GRAPHITES, TALC, RESIN and LIGHT MINERAL FACINGS generally used by shaking on the face of the mold have no particular effect on the sand due to the small proportion used.

FIRE CLAY is sometimes used in mixed facings, but is so exceedingly fine in grain that great care is needed to avoid excess fineness in the heap. This should be governed by frequent sieve tests. It is universally used in steel molds and cores as a binder where the molds are dried and is a necessity on account of the high temperature of the metal used.

MOLASSES is commonly used in the foundry in connection with the water used for tempering the facings, also for sponging the molds, having a tendency to harden the surface when dry. It is commonly used through a spray can, especially in connection with blacking, where the face of the mold is skin-dried.

When used as a binder for cores it serves the purpose, but the core, if it remains in the mold any length of time will absorb the moisture.

It has no particular effect on the sand heap.

KEROSENE is commonly used for sponging corners and the delicate parts in the mold where the sand has become too dry for the metal to flow over, where, if water were used a defect would occur caused by generating steam.

CEYLON LEAD (Mexican or Ceylon Graphite) is used in some cases for providing a clean surface to the casting, where mixed facing could not be used on account of the gases generated.

Where facings are prepared and mulled for general use in a foundry, usually a heavier grade of sand is used than that which is used in the heaps.

Great care must be taken against using it in excess where the jobs are being made in finer sand.

The surplus left from each mold will very soon affect the heaps and is easily noticeable in the bottle, by the increase in the grain size of the silica and the floating particles of sea-coal.

Its effect would be in the finish of the casting, it being the natural supposition that the fine sand is being used on lighter castings.

Agricultural work, sewing machine work, valve work, lighter work, general molding machine and bench work, medium heavy jobbing work, all require about the same grade of sand — medium grain and bond approximately 40% Vibratory Test. If large amounts of cores are used sufficient to weaken the heaps, the bond may be figured at 50% Vibratory Test. Care must be taken to avoid excess fineness if heavy amounts of bond are added.

The bond portion of the sand is extremely fine and if a sand too high in bond is used, it will close the sand and prevent the escape of gases, causing excessive loss. In such cases, it will be necessary to use a heavier grained sand to take up this bond and open the sand without destroying the finish of the castings.

THE VENT WIRE

The use of a vent wire in the foundry does not provide adequate returns for the amount of damage usually done to the pattern. Like many other foundry appliances it has its proper place, but its use is greatly abused.

Let us assume that a molder is venting a mold having approximately a surface of twenty square inches and that he makes four vents per second. This would appear unusually fast and if he vented at this rate for one minute, it would seem a long time, but he will have made only 240 vents. Would it not be far better to provide a small proportion of sand with a heavier grain size to add to the facing and provide thereby 2,400 vents in the same area?

Where the pattern is being injured by the use of the vent wire and it is considered absolutely necessary, a simple device would prevent this abuse by soldering a button or washer on the wire, which would stop at the mold surface, allowing the wire to pierce the mold to within one-half or three-quarters of an inch from the pattern. This is an old time practice but useful, though it is far better to provide a more open sand as mentioned above and eliminate its use.

CORE SAND

A great many papers have been written and strange to say, a great deal more research work has been done appertaining to core sands than molding sands, probably due to the fact that molding sands require a natural bond and the sands used for cores are generally silica sands with as little natural binder as possible.

The core is dependent upon an artificial binder, which must have three essential characteristics:

It must take the place of the natural binder and tie the grains to each other without closing the interstices and thereby stopping the flow of gas or vent.

It must harden after the core is formed, baked and cooled and it must release itself easily after the casting has been poured.

Producers of the various core-binders have made exhaustive studies of core sands about which books have been written and microscopic illustrations have been plentiful and even stereopticon views have been shown.

The reverse is true of molding sands, probably due to the uncertainty of the real reactions which form the bonding element.

Core sand to be efficient must have a very small amount of bond, just sufficient to hold the core in shape until the artificial binder has had time to replace it. It should be very open and have a grain as coarse as is consistent with the finish required inside of the casting to be made.

If fine bank sands are used, it is essential that it should be clean and carry a small quantity of natural binder—three to five per cent at least, Vibratory Test.

In larger castings heavy molding sands are sometimes used, together with burned gangway sands. This class of work is easy to control by the addition of high silica or sharp sands as openers and by various artificial venting methods.

It is fully as essential that the sand from which the core is made should be as well selected to suit the class of castings to be made and every precaution taken to secure a thorough mixture, as it is to provide a good moldnig sand.

Castings very often having a satisfactory surface finish on the outside are radically different on the inside, rough, scabbed or eaten into by the metal. Roughness is usually caused by a poorly mixed coarse sand or an insufficiently packed core. When the grain of the sand is too open, it may be coated with a mixture of plumbago and molasses water. It is better to use the wash as thin as possible when applied in order to have it take a good grip on the core, at the same time filling the openings between the grains on the surface.

Core sand cannot be too well tempered! Very often blacking is applied to the core, with the solution too thick. This only forms a thin scale on the surface which will peel off of the core when the metal strikes it, causing a so-called scabbed casting.

On steel castings, when a silica wash is sometimes used, the aforementioned requirements should be the same.

SYNTHETIC SANDS

Producers have devoted much time and effort to satisfying the foundrymen's wants.

This has proven extremely difficult on account of the want of a bona fide knowledge of what the actual requirements were.

Some producers have combined several good grades of sand of different characteristics and have had fairly good results—others have just dreamed of the combination of sand and clay and have not been successful.

Synthetic sands if they are to prove successful, must be copied from the works of nature in their production as the sand takes on the characteristics of the rock from which it comes. These characteristics are the cleavage, or shape of the grain; the chemical, or the color; the class of rock or the heat resistant; the hardness or the bond.

In marble the grain is crystallic; the color is white, the heat resistance low and silicates from marble will wear fine, but are slow to combine with iron or alumina.

In granite the grain is crystallic, the color is red or gray; the heat resistance is high and the silicates from granite are fine, abrasive, but slow to combine with iron or alumina.

In sand-stone the grain is granular; the color is red, white, yellow, gray or black, the heat resistance is medium and the silicates are extremely fine and soft and are easily combined with iron or alumina.

Slate is fine of grain. Its color is gray, green or black; the heat resistance is low and the silicates combine with alumina or iron.

Use of foreign materials in connection with the regular foundry sands very often have an effect which would ultimately result in the condemning of a perfectly good sand.

The practice of using silica sands and fire-clays in making synthetic sand appears to be the dream of some foundrymen at the present time. The use of either should be carefully watched. It must be remembered that *silica sands destroy bond* and *fire clays increase fineness in the heap.*

There are many ways that the above materials may be used for specific purposes, without harm, particularly in steel production, but in the ordinary castiron foundry they are apt to do more harm than good, unless the proportions are carefully watched and not used in such proportion as to eventually destroy the heap, creating a greater loss in castings through weakness.

Fire-clays becoming fine and filling between the regular grains destroy permeability or porosity of the heap.

Silica sands in excess destroy the finish of lighter castings.

By the term silica sands is meant those commonly used as sand-blast sands, beach-sands, etc., generally of coarser grain than the heap sand, which having absolutely no bond of their own must necessarily be weakened. To open facing sands, they should be only used in *measured quantities* and of a minimum amount.

Where mixtures of these materials are necessary in connection with the molding sands, thorough blending is absolutely necessary. *Mulling, riddling* and *revivifying* or *areating,* all of these are necessary—the absence of either may result in losses caused by uneven sand conditions.

They would also affect the fineness of grain and a close watch should be made of the excess fineness or excess coarseness of the heap.

Materials used for preventing the sand from fusing to the castings also have a very decided influence on the strength or weakness of the heap sand.

FOUNDRY PRACTICE

EQUIPMENT

1870 to 1890 were years of constant experiment in the development of the molding machine. Since that time, the development has almost reached perfection.

METAL

1885 to 1905 were years of constant experiment in the application of chemistry of iron. We all know the wonderful progress made since then. Previous to 1885, chemistry was applied mainly to steel production.

SAND

1910 to 1920 marked the start in the most important study in foundry practice—SAND. Will the next ten years solve this little understood problem and stop the enormous waste of castings caused by the use of improper sand or the improper uses of sands?

The studies up to the present time have been mainly from the academic point of view and very little of a simple form, which could be easily understood by the workman himself has been offered.

Technical terms and elaborate tests do not appeal to him. In our grandfather's time his only test was to dig his fist into a sandpile and judging its strength or weakness by squeezing it into a ball, thus determining the fitness for his work. He knew nothing of *colloidal* clays.

Permeability and *porosity* were not foundry

Albany Sand

terms. The vent wire and its prolific use were his means of caring for the gases.

The finish of his casting was usually predetermined by the size of mesh in the riddle he used, or the preparation of his facing sand, and in some cases by returning his pattern to the mold after covering it with a material which would serve the purpose.

When his sand was weak and he could not draw his pattern from the mold without dislodging particles of sand, which caused his castings to be rough, his main recourse was the swab or sponge. Where dropouts and bad lifts occurred his only recourse was the excessive use of gaggers, soldiers, nails, etc.

Considering the many little details necessary to the molder to avoid the loss of his casting, the chances of which must be predetermined, he might well be forgiven for the usual use of profanity the next day when he finds it thrown into the scrap pile.

When we shall have arrived at a suitable method of determining the proper measurement of bond or clay required for the various grades of work and the grain size best suited to these grades, the use of the vent wire, swab and gagger will be eliminated except in extreme cases and scrap losses be reduced to a minimum.

SCRAP

The loss of castings in the foundry and machine shop, commonly called *Scrap* has been the source of many misunderstandings, arguments and harsh words, particularly in the foundry.

It is hardly probable that it can ever be entirely eliminated, but it is possible to reduce scrap in any foundry to a minimum. Three things absolutely control this phase of foundry work: *Equipment, Metal* and *Sand.*

The day has passed when the foreman or assistants, who through their own ignorance of the causes, or negligence of conditions, would reprimand the molder, even to the point of discharging him, where, if the real truth were known the cause of the loss was the foreman's neglect of one or all of the three causes mentioned.

Time spent over the scrap pile by officials, inspectors, theorists, etc., after the scrap has been made is absolutely wasted. The same efforts put forth previously could have prevented this loss or the greater part of it.

Did it ever occur to you that the run-outs you see in walking through a foundry were caused by weak sand or overcrowded flasks? Strained and swelled castings in the pile from the same cause, and that you, Mr. Foreman, had indirectly caused this loss by not giving sufficient attention to the material you had provided your molders to work with.

Does it ever occur to you when you see a molder just about to close his mold and have it drop out, that you have not given sufficient attention to the equipment your molders are required to use and keep their own flasks in makeshift repair?

Does it ever occur to you when looking at your molder swabbing a mold, with a large hemp swab, splashing water around and on the pattern that you cannot pour hot metal in water without changing its condition and that this is destructive to the pattern as well?

If you have prepared him a suitable facing for his castings does he not change its condition? Would not a mild word of advice to the molder at the time save a later loss and the usual resulting harsh words? Assuming that you have given him a suitable facing, the use of a swab is unnecessary.

Does it ever occur to you when giving the molder a certain class of casting to make which has previously been made many times that the patterns wear out sometimes and may have been subjected to accidental injury while in the pattern storage, and that a few moments of honest inspection by you or someone whom you have selected and can hold responsible might save many vexatious losses?

These words are not written with the object in view of criticizing the foreman, but to bring to view a few of the many little things which he is required to look after and that his lot would be a much better one, if he were given assistance, not criticisms by his superiors.

Scrap may be caused in many ways, but it will invariably be found to have been caused by poor metal, defective or faulty equipment, or some condition of the sand or its treatment. The scrap may be classified under these three headings which if all were in perfect condition there would be very little loss left to attribute to the workman.

Metal	*Equipment*	*Sand*	
Slag	Shift	Dropouts	Crush
Misrun	Strain	Strain	Rough finish
Coldshut	Crush	Blow	Leakage
Shrinkage	Dropouts	Scab	Hardness
Pinholes	Runouts	Coldshut	Runouts
Hardness		Slag	
Leakage		Pinholes	

It will be seen by the foregoing divisions that the number of defects which may be caused by sand is as great as that of the equipment and metal combined. Does this not show the great importance of giving the *sand* and its tempering devices the greater attention if we wish to reduce our losses to a minimum?

Dropouts, strain, swell, runouts, scab, crush, leakage, may all be caused by weak sand, or in other words, not sufficient bond. Blow, scab, coldshut, slag, pinholes, hardness, may all be caused by strong sand or that which has too much bond. The latter losses may also be caused by strong sand over wet.

By classifying your losses you will very easily determine the division which is causing your greatest loss and by removing the cause you will accomplish a great deal more in reducing the loss than you will by standing over the workman finding fault.

TEMPERING SAND

One of the most important requirements in foundry practice is the *Tempering* of the molding sand, or preparing it for the reception of the molten metal. This is done by use of the shovel, riddle and tramping of the sand over and over until as near as possible every particle of the bonding element in the sand is associated closely with its proportion of the grains of silica and holds them together during the molding operation without closing the interstices between the grains and preventing the proper escape of the gases which are generated in the mold.

In the above are mentioned three distinct operations—

The *Shovel* conveys the sand forward, and the backward movement and blow of the shovel breaks the lumps and smooths out the irregularities of the mixture.

The *Tramping over* the sand packs the bonding elements closely to the grains, causing them to adhere to each other at the point of contact.

This description minutely describes the operation of the molder when preparing a special facing with the exception of the moisture and sea-coal used to suit the casting he is about to make.

All sand tempering devices now used in the foundries throughout the country must be based upon one or the other of the three foregoing requirements and to produce a perfect mixture, all three operations must be duplicated.

Riddling the sand alone is not sufficient. Milling or rolling the sand alone is not sufficient, and mixing alone is not sufficient, but each must be cared for in your sand tempering arrangements.

The muller or roller type mill of which several good makes are to be had will serve the same purpose as the molder in tramping over his facing.

The riddle the molder uses has been replaced by many excellent devices, revolving and oscillating, operated by air, electricity or belt-driven.

Sand, which has been properly proportioned in bond and silica, and so thoroughly blended that when placed on the pattern every particle of surplus moisture is eliminated and so areated that a smooth, velvety feeling is acquired, should give an excellent finish to the casting and dispense with the necessity of the use of vent wires, sponge or swab, and your losses should be reduced.

If troubled with blowed work, coldshut or scabbed work, do not blame your molder—blame yourself for not having provided him with suitable material to work with, just the same as though you had furnished him with a cold metal or improper mixture.

If your molders use swabs excessively and your patterns are destroyed by the excessive use of the vent wire and your scrap losses are high, it is safe to assume that your sand has not been properly blended and tempered. Whether your sand be of fine or coarse grain, it is important that the bond be sufficient to secure the mold, but not in excess. The latter condition is always indicated by a tough rubber-like consistency of the sand after tempering.

It is important that the grade of the sand you use is of as heavy a grain as possible, without danger of destroying the finish of your product and it is also extremely important that excess moisture be avoided.

When the sand in the mold has been absolutely tempered and is of good open grain, you may put away the vent wire, destroy the swab, ram or press your mold as hard as you please, without danger of loss.

When in doubt as to the cause of your losses, *Temper your sand.* If you have sand mixing machinery, keep it in order and work it overtime.

If your core sand is given as much attention as the molding sand in mixing and tempering, you may reduce core binders and eliminate smoke in the foundry. It costs money to make smoke and it is absolutely unnecessary in the foundry, if the sand is tempered properly before making the cores.

A mold made from sand which is properly tempered should never show spots of new sand. When they do show, you are not getting the full benefit of the bond in your sand; in fact, these spots harden into small balls of new sand coated with old and act as a weakener besides destroying the finish of your castings.

Excess use of new sand is extremely wasteful as when it is not fully tempered it will adhere to the hot casting and the bond is carried away.

No matter how good a grade or quality of new sand you may have, it will be a source of loss if it is not thoroughly blended with the old sand. In many foundries it is noticeable that the losses are much greater during the winter months. The moisture in the sand becoming frozen it would be unreasonable to expect that metal would lay to it without trouble. Thorough tempering of the sand will greatly relieve this condition.

In the production of green sand cores, or in other words, cores made from the same sand as the mold itself, tempering thoroughly is the most vital requirement. An open sand is required and to obtain the full value of the bonding material, it cannot be too well prepared. Neglect or slighting in this can only result in the loss of castings.

SAND TALKS

A little attention by the foundryman to his sand conditions the first hour of each day will save him many worries later over losses.

Clean gangways, orderly sand heaps, well tempered, indicate small scrap heaps.

New sand is like medicine—small doses at proper intervals and well assimilated, cure many ills.

Excessive losses from runouts, strain, scab, streaky castings, roughness in drag side from flow of the metal, indicate weak sand.

Five minutes with the Vibratory Test will insure you against fifty per cent of the above losses—*Cheap Insurance!*

Added water does not mean added bond.

Many slag problems have been attributed to the metal, which really were entirely due to sand improperly treated.

SHOT IRON, PEBBLES, ETC.

A common occurrence in almost all foundries is the presence of small shot-like balls, which come from several sources:

One, sputtering of metal from wet ladles, spillings along gangways, and on the tops of molds, etc.

Two, where the binder is in excess in cores they become hard and flinty and in the tempering of the sand they are crushed and broken into small particles instead of the grains of sand falling apart. These small particles pass through the riddles used remaining in the heap. In the frequent movements of tempering they take on a coating of moist material, forming into balls.

Three, where the new sand is excessively high in bond and passed through the riddles in the form of clay particles, later drying out, forming hard centers covered with fines from the heap, also forming shot-like balls.

The constant accumulation of these balls, later becomes very annoying, causing many little troubles and defects.

The accumulation of these particles, particularly the increased weight of the metal balls, calls for an increase of the bond which only means trouble from other sources.

In the use of the riddle over the pattern these balls passing through it, roll quickly down to the parting line and into the corners causing an irregular parting and roughness. This also very often causes the sand to break away at the partings, leaving an ugly and rough finish to the casting.

Where the metal balls rest on the pattern and are exposed to the hot metal a slight explosion is caused which creates pitted castings often so hard to account for. Very often these small metallic balls are found fused to the casting when the mold is shaken out.

The balls caused by hard cores also create pitted surfaces and even create pinholes on the surface at times. The gases formed by the binding material in the center of the ball when the metal strikes it follow the line of least resistance into the mold and being held by the metal, expand, causing the pinhole. Occasionally these gases in the ball cause it to explode and often a small particle of core will be found imbedded in the surface of the casting, which is difficult to account for in any other way.

The clay balls have no other effect than destroying the finish of the casting by roughness and pits.

The use of a magnetic separator would remove the metal balls, but would have no effect upon the clay, coreballs or pebbles in the sand. The magnetic separator would remove the metal immediately and for several days would prove valuable, but as it takes some time to accumulate enough to be harmful it is not profitable to run it continually.

The simplest way to remedy the condition is to set certain periods, about three times a year and have all molders use their riddles and throw the tailings into boxes for the purpose, having someone remove these to the dump. It is a poor practice, but a com-

Zanesville, Ohio—Method of Labeling Tests

mon one, for the molder to riddle the sand over the pattern and then dump the remaining tailings into the mold and into the heap.

When these conditions become exceedingly troublesome they may be partially remedied by taking barrows of sand from the heap to a muller, passing same through the muller until it becomes smooth, having a tough rubber feeling, caused by the distribution of the increased bond from the clayballs. Returning this to the heap and throwing out all tailings from the molders' riddles will soon give relief.

The foregoing conditions existing in the sand are generally ignored or overlooked, and yet if an even finish to the castings is desired, this matter should not be neglected as it is unfair to the grade of sand you are using, no matter how good or how poor it is.

GATING CASTINGS

Improper gating and pouring methods have been responsible for condemning more good sands than any other operation in molding. Some foundrymen seem to think all that is necessary is to have a thoroughly tempered sand and that it should then be able to stand all the abuses which can be given it.

There are more forms of gating castings than there are hairs on a cat's back, but there does not seem to be any set form of gating nor rules applicable to all foundries.

Very often castings are lost due to sand conditions and a change of gating is advised. Then, again, when the loss occurs through improper gating, the sand is condemned.

Gating must be considered as a part of the equipment and no changes in gating should be made before it is known that the other two items, i. e., sand and metal, are right. It is to be hoped that the future will bring out uniform standards for each.

Probably no one item exerts a greater influence upon the losses in a foundry than *force* in the flow of the molten metal through green sand molds. Starting at the ladle lip the iron drops a dead weight to the bottom of a sprue, tearing at the sides of the sprue, cutting out the bottom and carrying the loose sand through the runners, churning the dirt and metal together, rushing into the mold, cutting the walls of the mold at the runners, creating the so-called scabbed work and forming the so-called slag spots, in the castings and many other defects.

The first step in trying to check this force has been to form a basin or pouring dish on the top of the mold with a channel to the sprue.

The common practice is to increase the speed of pouring to choke the sprue, regardless of the fact that the sprue may be greater in diameter than the stream which is poured from the ladle lip. This practice only aggravates the tearing action of the metal in the sprue. The better way would be to reduce the diameter of the sprue to suit the volume of metal needed in the casting.

Many forms of check have been devised to stop this force at the dish or basin. One of these was devised some years ago and used considerably. The basin was made round and a castiron disc with tapered perforations was laid in the bottom of each dish. When the metal was poured it passed through these small perforations, entering the sprue easily at first and as the castiron disc melted away, the volume was increased later sufficient to run the casting.

Another form of check similar to the above and of recent date is a parted core, with perforations inside in one part and a dish combined.

In certain classes of work where rush pouring conditions prevail, these have given good results. Both forms of check make additional equipment necessary.

Another form of check was advocated some years ago and is still largely practiced on gated work. This is to widen the runner at the base of the sprue, sometimes forming a circular plate one-quarter inch to three-eighths inch thick, depending upon the amount of metal required in the castings, the diameter of this plate usually measuring two to four inches. The principle attributed to this form of gating was that running metal through a thin plate would produce clean castings due to its skimming action. As a matter of fact, it was simply another form of check to the force of flow in the metal. There are many drawbacks to this form of gating as the thin plate requires an increased height of the sprue to increase the pressure.

Several forms of loose gates for floor work and jobbing bench work are devised to act as a check. One is in the form of a block which is laid on the follow board or matchpart and rammed up in the dragside. This block has coreprints on the sides and when a pattern is withdrawn from the mold a core is dropped in, which allows the metal to pass through a runner bar under the core connecting with a continuation of the bar on the opposite side. This forms a decided check in the flow of the metal.

For light work, rapping patterns, one-half inch diameter core prints have been put on both sides of the runner bars near the sprue, and stock one-half inch cores inserted across the flow of the metal. The metal flowing under the core is subject to another check to the force of the flow.

The same effect may be had, if room in the mold permits, by inserting a ring one inch in diameter in the runner bar. This makes its own core and check by making the metal flow around the green sand core and back to the bar.

In floor molding it is a common practice to place a riser by the side of the pouring sprue. The intent of this riser is to check the flow of the metal and relieve pressure. It is commonly called a skim-gate.

In smaller lines of work it has been a common practice to use covered risers in the form of small blocks, sometimes round, sometimes square, at various points along the flow of the metal, the intent of which is primarily to check the flow. Unless very carefully devised and properly placed, this form of check can be made extremely wasteful with doubtful benefit to the castings.

The covered riser or head is useful only where it is necessary on account of unequal contraction and shrinkage takes place in a casting, and then it is only used to keep the lighter points of the casting hot longer, so that the contraction may be made uniform throughout the castings. In some instances the height is depended upon to increase the pressure upon the casting, while the metal is hot, as a shrinkage head and properly placed it is very useful, but as a so-called dirt head it relieves force but as it is used in many instances thoughtlessly it becomes extremely wasteful.

It would appear almost impossible to have any two foundrymen agree upon one particular form or type of gating castings, due to the enormous variety of castings made, metals used and working conditions, each foundryman being guided by his own experience in trying to avoid losses. And, there is no question but that the foundry foreman goes through more *trying* experiences than any other class of men on earth — trying this — trying that and trying the other, upon the advice of people who seem to think he is not trying and finally he makes up his mind that scrap has just got to be, and he stops trying, then usually gets along just as well.

We can agree, however, that certain causes will create certain effects. We can also agree if the causes are shown to be in the sprue, bar, feeders or runners, the effects must show in the castings.

Starting with a large sprue, then going to a sudden reduction in the runner bars, also a sudden reduction in the feeders or runners into a mold can only cause a hose nozzle effect of increasing force in the flow of the metal into the casting. Study your gates and note the results when the above conditions are reversed.

The effects of force are easily discerned by carefully following the flow of the metal as shown on the bottom side of the runner bar and around the base of the sprue, also at the entrance point of the runner into the casting. The sand will be shown as cutting or washing away at these points by the roughness and the materials as carried away are bound to show elsewhere as slaggy, dirty or leaky castings.

Very often in checking force, a serious error occurs. Where the size of the runners have been reduced until too great a volume of metal is poured through too small a runner usually resulting in a so-called slaggy casting. Invariably the runner and surrounding surface of the mold will be found cut away, and if the sand is exceedingly fine, close examination will disclose small round spots where the sand has become fused, unable to resist the concentrated heat of the metal. If a core is used directly in front of the runner, examination of the inside of the casting will disclose a cut in the core or a scab-like peeling of the core, particularly if it happens to have a hard glazed surface. Where the core has peeled as described, a thin fin of metal will be usually found behind this scab and when the casting is cleaned, there will be found a hollow spot in the surface of the casting which conforms to the shape of the sand that has curled up. This condition is often found where cores are too close in grain, having a hard, shiny, glazed appearance. It also often occurs where a fine core sand is used which has too high clay bond content, which causes a glazed surface on the core.

Another condition occurs where runners are too thin and the casting heavy. The volume of metal being too small with force behind it causes it to be sprayed into the mold, creating little shot-like particles of metal which are often noticeable on the surface of the casting, surrounded by a pinhole. This globular particle of metal is often found imbedded loosely in the hole and can be turned around in the hole without falling out. Evidently the spraying, sputtering or boiling action in the metal causes a scintillating spark identical with that which flies from the cupola spout or ladle when the metal flows into it.

The spraying of the particle oxidizes it exactly the same and the gas given off prevents the metal from setting to it and if the particle has been completely oxidized or burned, it becomes simply a cinder which is often picked out and attributed to slag from the cupola, whereas it was formed right in the mold itself. This slag generally disappears when the casting has been cleaned, leaving only the pit or pinhole on the surface.

The addition of more runners, reducing force by increasing the volume usually remedies the above conditions.

A common practice in the gating of plate patterns and sometimes with rapping patterns is to leave a "raised" button on the bar directly under the sprue. This creates a heavier section at this point.

With the force of metal from the sprue and the decreased opening into the bar a cutting action is created and if the casting is closely examined the sand will be found to have cut away on the bottom of the bar at this point and if the top of the bar is closely examined in the general direction of the flow of the metal toward the casting, there will be found numerous pits and marks of the sand which is cut away and some of this is bound to reach the casting.

This will very often be found the source of so-called rat-tails and dust which prevents two parts of the metal from coming together and fusing properly in this case being misnamed as a coldshut. If such streaks are examined closely they will be found round-edged caused by the dust and if the casting is broken the crack is only part way through.

Reaming out the bottom of the sprue excessively is an extremely careless practice and costly, spoiling many well made molds. To clean the sprue is all right, but overdoing it leaves large, dirty heads filled with loose sand which cannot withstand the flow of metal.

Treatment of sprues, bars, runners, etc., by the molders result in many losses, which at first are mystifying and conclusions are generally jumped at too quickly as to their cause.

A close search for the cause will usually result in finding a mistreatment of the sand in the bar, sprue or runners, or an excessive use of a swab or sponge, pouring water along both sides of the bar and across the runners, even dropping it into the mold. You cannot reasonably expect molten metal to flow quietly between two walls of mud. The sponge or swab have their place in foundry practice, where molds are tediously finished and the sand is exposed to air drying, but their excessive misuse can only result in one thing—*scrap.*

In the construction of bars and runners, many little things will cause trouble. Weak, sharp corners of sand are often left exposed to the flow of the metal. Back draughts in the construction are often neglected and the sand is torn or disturbed in drawing the pattern, making it necessary to sponge or patch.

A patched mold is never just as good and is the cause of many defective castings.

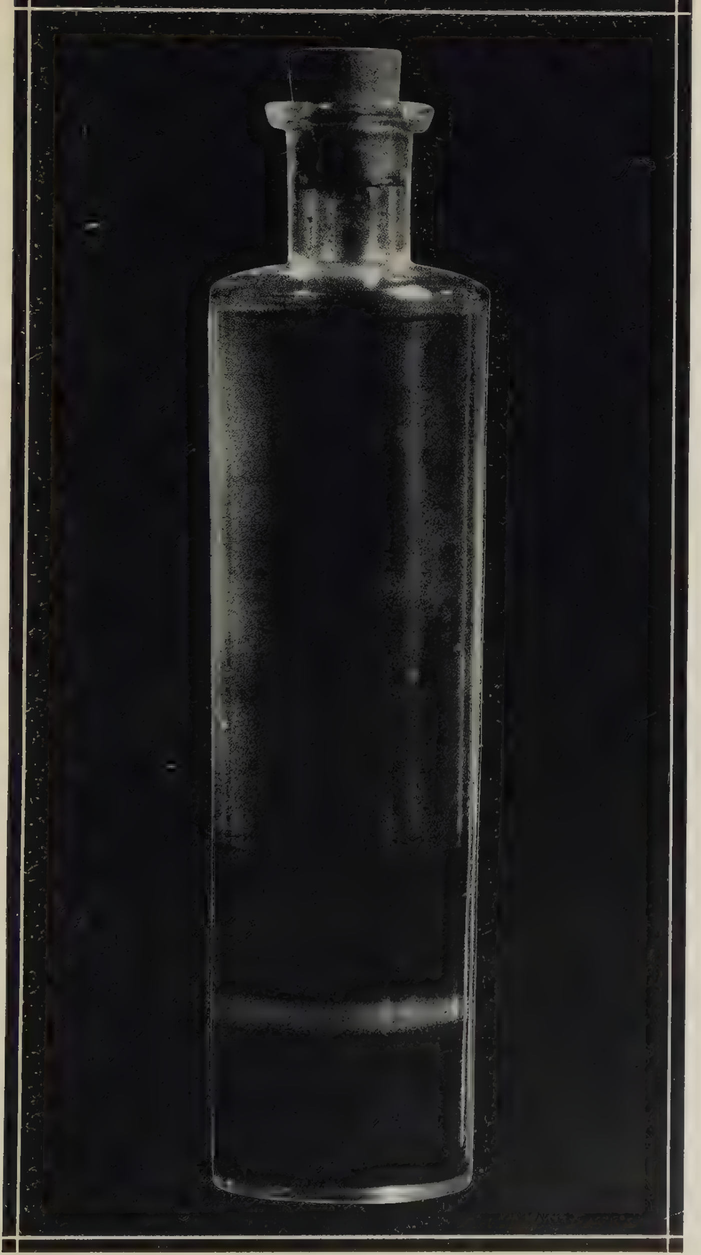
There are thousands of forms of gating castings, theories of pouring and no one part of molding has been more thoroughly abused. There are many forms which are no doubt good and if so it will be found that their principal virtue is that they provide a check to the flow of the metal, which eliminates force.

There are flat bars, thick bars, square, oval and triangular bars, heavy, light crooked and straight bars; wide bars and narrow bars, all used without any regard to regularity or relation to the castings to be poured. The only rule known is the whim of the patternmaker who is supposed to know, or that of a foundry foreman who has a hobby for some one type of gating. And again in many cases it is left to the molder who is trying to produce good castings, but is compelled to cut his runners in a lack of space left for him by the patternmaker or to suit flasks too small for the job.

Only one thing is absolutely certain—the molder will be reprimanded if defective castings are produced.

There are numerous forms of swirl gates in which the metal enters one side of a block or head, takes on a circular motion and leaves the block at the bottom or at right angles with the entrance. The virtue of this form of gating again rests in providing a check to the flow of the metal.

There have been several of these which have been



Sand from the Heap

Note how the camera brings out the layer of core sand between bond and silica, also line of seacoal at top of water.

patented as skim gates, supposedly retaining slag or dirt which flows with the metal.

Horn Gates, as their name implies, are horn shaped, tapering generally from one inch at the entrance to one-half inch at the outlet into the casting, and having different lengths to suit the class and size of the casting.

This horn is placed to rest on the follow board or match with the small end resting on the bottom of the pattern and the drag rammed up. A sprue is placed about three inches away from the horn and when the cope has been lifted a channel is cut from the sprue to the horn gate. In the use of a horn gate, it is generally advisable to increase the height of the sprue slightly on account of the back pressure of the metal as the mold is filled.

There are many instances where no other form of runner is suitable.

Top Gates or *Wedge Gates*—This is one of the oldest forms of gate known, being a combination of basin, sprue and runner, generally wedge-shaped and of varying lengths and depths to suit the varied classes of work. The top is usually one inch to one and one-half inches in cross section, tapering down to within about one-half inch of the pattern and from there to the pattern straight, one-eighth to three-sixteenths thick. Any number of these gates may be used to suit the castings being made, which are usually flat work, stove plate, piano plates, mantel work and some forms of hollow ware.

The strange feature of this form of gate is that it requires force in pouring, the metal being really dumped into the head and kept full until the mold is entirely filled which usually takes about three seconds from the time the ladle is tipped. It is essential that all sprues are filled at once for if poured slowly the runner would cut at the casting. The sand is usually very carefully pressed back along both edges of the runner with a slicking tool, care being taken that no loose edges of the sand are left to wash into the castings. The wedges are left in the cope until this is cared for and then lightly tapped to loosen and withdrawn through the cope and loose particles blown away.

Knife Gates—This is another form of runner similar in character to the wedge runner, only that it is set vertical against the side or edge of a pattern where a horizontal runner could not be used. It varies in depths and tapers towards and within one-half inch of the pattern.

The pouring is not done directly into this runner, but it is connected in the regulation channel to the sprue a few inches away. The flow of the metal should be checked by angles or other means before entering the runner. Care and cleanliness are necessary to avoid trouble in using this form of runner.

A round bar is always preferable to any other form, flat, square, or angular, on account of excess friction.

Sudden reductions from heavy bars to light feeders or the reverse condition should be avoided.

When once the force of pouring the metal into the mold has been properly checked, the maintenance of a steady volume of flow into the casting will give best results.

Always remember that unusual disturbances, rush of metal, etc., create conditions under which no sand, no matter how good or well tempered it is, can possibly stand up.

The relations between the sand used and the form of gating cannot be ignored. Very often more than one sprue is necessary for pouring castings. The general practice is to connect these sprues by building some form of runner bar across the top of the mold, usually poured with crane ladles.

In some forms of work, soil pipe, etc., long one-half round ladles are used with two or more lips as occasion requires and the molds poured by hand.

In steel, very large pouring heads and risers are used primarily to stop piping or shrinkage and to suit bottom pouring ladles usually used.

There are many forms of gating castings in loam and dry sand work in the heavier lines, generally governed by the conditions and type of work to be poured.

The various types mentioned here are only those which are generally used and covering many grades of castings.

Many losses may be reduced by having some of the bars and runners of troublesome jobs thoroughly cleaned and examined closely for little irregularities along the flow of the metal through the bar and runners, roughness of the surface and indications of boiling action, cutting action or pitting effects of improperly mixed sands.

These variations will invariably be found to be the source of defects further on.

The ideal gate is one which after pouring is as perfect as you would expect your casting to be.

THE SAND SALESMAN OF THE FUTURE

The day of the high pressure salesman, who depends only on his oratorical ability to sell sand, using many subterfuges to impress the buyer with the virtues of his sand as compared with that of Bill Jones, or the Scenic Sand Co. and sometimes often stretching a point, has passed. He invariably goes away with a trial order, at the same time, not sure but hoping that some lucky accident may allow him to keep this new addition to his sales.

The sand salesman of the future will undoubtedly find it necessary to obtain a knowledge of the foundry and the many little details which are necessary to a sand to avoid losses caused by it, or such matters of abuse of sand in the foundry which cause it to be condemned without adequate reason.

It will become necessary for him to familiarize himself with foundry scrap and how far his particular grade of sand will go towards eliminating it.

No doubt there will come a time when sands will be bought and sold by some universal standard of expressing its value in simple terms and figures, with which all concerned shall be familiar, the same as any other commodity is handled. To arrive at this ideal condition it first shall become necessary to adopt a standard method for all concerned, and this standard must be arrived at by the foundrymen themselves, who must be able to say what they want and no doubt the salesman will place himself in a position to give them what they want.

It is not assumed as yet that the Vibratory Test is the right method, but it will have started something from the foundryman's point of view. Anything to be acceptable to the foundryman, must be written in the terms of the foundry and to suit the needs of the foundry.

In our study of molding sands and their development, we must not forget the work which has been done by the men who have given their time, labor and money to develop it. The prospector, miner, shipper, salesman combination, usually centered in the brain of a single individual with nerve enough to tackle a hard proposition *"all of the way."* The man who put on his high-topped rubber boots, carried the shovel, climbed hills, went down into the river bottom lands and along the highways prospecting, after finding a "lead" which might prove worthwhile; dealt with the farmer or land-owner, arranged for trials by the foundryman, arranged for leases and removal, railroad facilities, rates, etc. His has been the financial venture. Having no set rules for measurement either of grain size or chemical requirements, he took the chances, investing his money, paying the diggers and loaders, arranging and paying for the installation of side tracks and the setting of cars in the proper places, for loading at the right time, furnishing loading machinery, industrial tracks, etc.

Sand can only be dug and shipped in good condition about six months of the year and the sandman has to make his sales in the meantime, and arrange shipments to suit the convenience of the foundryman.

He has also to listen to the whims and complaints of poor service, and sometimes put up with rejections, reconsignments, etc., many times at a loss.

In consideration of all this we are compelled to admire the nerve and persistence shown in the development of this industry by the pioneers. In other words, we would advise the foundrymen to have a heart for the sandman.

Gradually the shippers are developing better methods of selecting the sands at the pits by adding blending and mixing machinery, grading the sands to suit the various kinds of castings as required by the foundryman.

Naturally the man who delivered sands for many years without serious complaints, from the run of the pit must now meet the conditions of others who use improved machinery and advanced methods.

The foundryman is not particularly interested in sand literature—what he wants now is to be assured that his sand will maintain a uniform grade, texture and strength, so that he may avoid such losses as were incurred in the past. And, no doubt the sandman is putting every effort to meet his requirements and the sales of the future will no doubt be based more on quality than quantity and price.

Apropos the sand question, is the story of a sandman who invited a foundryman friend to visit his pits at his convenience. The foundryman came and in looking the ground over selected a certain space in the run of the pit from which he desired his sand dug. As a landmark, there was an old tree stump in the center of the spot he selected. Sands were shipped and the foundryman satisfied, but as many others wished sand from the same location, later on the supply was exhausted. The friend, not knowing what else to do, moved the stump to a new location and he claims that later on his foundryman friend visiting him again, seeing that the stump was still there, went away satisfied, leaving the sandman to have a hearty laugh over the incident. In the present day, the trick would hardly work to advantage.

The foundryman using a high bond sand from one shipper and a low bond from another would soon know, if he was making his daily tests, whether either shipper sent him a sand in a varying grade and the shipper would soon receive less orders, leaving the foundryman in a position to *"move the stump."*

A WORD TO SAND PRODUCERS

In your search for new fields, what is your usual practice? When you have found what you want, and think you have a good molding sand, you select several barrels for samples to send out to your prospects for approval and possibly you obtain an order for a carload on trial. You have no positive assurance that it is suited to the class of work to be made. Is it not largely "trust to luck?"

The Vibratory Test would show you within twenty minutes of receipt of the sample, its bond, its openness, its grain, and by color, its class.

You would have to waste no time by submitting to a shop making carriage trimmings or work to be plated, a sand which would be much more valuable in a malleable iron shop, or for medium castiron bench work.

A Word to the Sand Supply Man

You do not confine yourself to but one grade of sand. If you did your income would be very small.

When you approach your prospect now, how do you go about it? Walk into his office, open up a half dozen tin boxes containing several tablespoonsful of sand and expect him to judge a carload by squeezing the sample into a ball, rubbing it between his fingers and it generally winds up that if you have made a sale, it is only because of your personal work and if it so happens that the sand when received does not prove satisfactory, you have lost a good customer.

The better way would be for you to test your sand by the Vibratory Method, so that you will know your sand before you start out. Take your test samples with you and show your customer that your sand is the best for his class of work and prove it. This way, you will make a satisfied customer and keep him.

A Word to the Foundryman

Eastern sands are more open than Western sands. The Eastern foundryman should carry extra new sand which is high in bond. Western sands are high in bond, hence the Western foundryman should carry a sand high in silica. The Vibratory Test will show each what is needed and assist in choosing it.

In choosing your new sand make sure that it cannot be obtained locally before going elsewhere—transportation costs money.

Just because you have a plentiful supply of new sand is no reason why you should waste it.

If you are making a product which requires air, water, or steam tests and you are troubled by leakage, *do not be too quick in blaming your metal.* Examine your sand conditions and test your sand for fineness or silt; also for excess sea-coal.

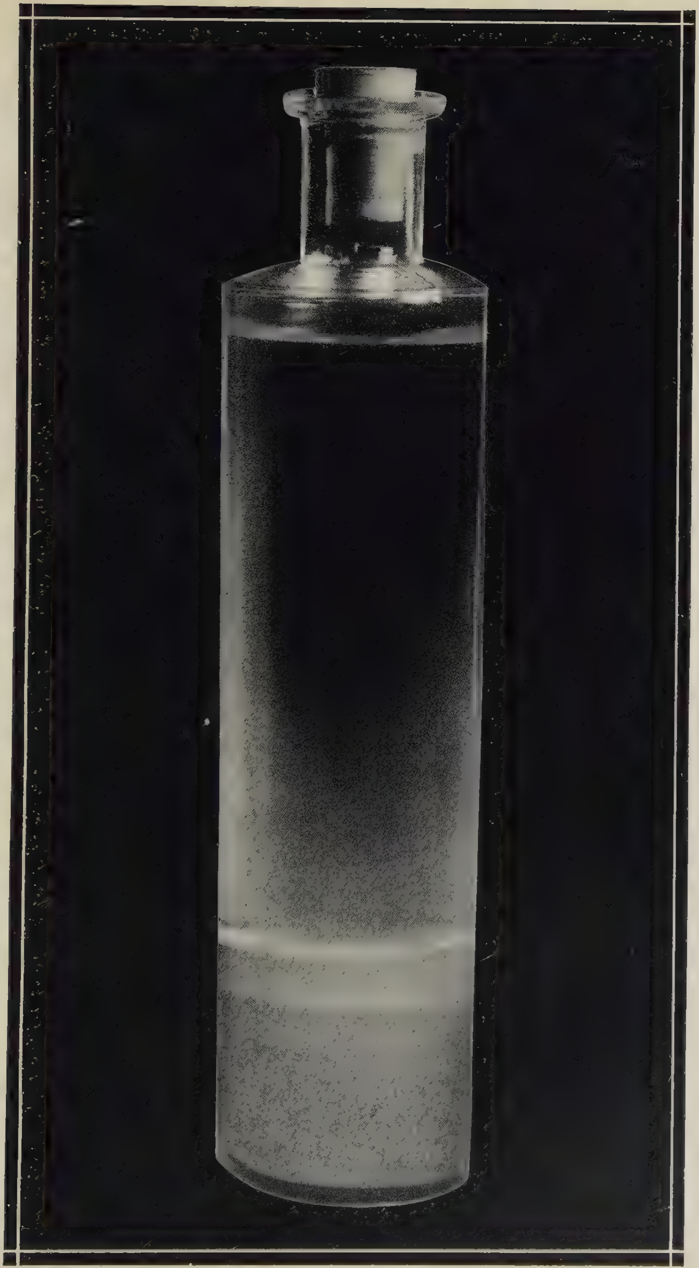
If you use heat under your patterns, *examine the castings for signs of cut or markings of the flow of the metal.*

In making light plate work, if troubled with pinholes, commonly attributed to metal, *examine your sand for the same sources as above mentioned.*

However, the sand and its care alone will not reduce losses to a minimum—good hot fluid metal is essential as is also good equipment, which should be well chosen and properly cared for. Proper attention to the foregoing will save you dollars.

Spend as much time and thought in making the Vibratory Test applicable to your own shop conditions as you would if you were required to prove it wrong and you will find it profitable in many ways—conserving your new sand, reducing scrap and improving the appearance of your castings.

Get out of that old rut of trying to test your sand by squeezing it into a ball or holding it to your ear while rubbing it between your fingers. This doesn't mean a thing, for you cannot write down on paper how it feels, neither can you tell your manage-



West Albany Sand

ment how it feels. You cannot express your feelings unless to cuss the salesman who sold you a car of sand not suitable for your work and then you can't prove it.

It does not require a college education to study scrap. Scrap piles are like old rent receipts—you have paid for something you cannot sell. When your records show everything running fine—*find out why.* In a production foundry the scrap should be divided into as many classifications as possible in order to ascertain whether or not losses are directly traceable to sand conditions.

With the sieve test we are not so greatly interested in the average of the grain sizes as we are in the excess coarseness or excess fineness of the sand.

The foundryman having first arrived at the grade of sand best suited to his own line of work and which gives him the least loss, should occasionally test the fineness of his sand, not for average fineness, but for excess fineness or excess coarseness.

In almost all foundries from time to time, sands from the mill room and other places in the form of a dust or sweepings, reach the heap, which through their excess fineness or coarseness would easily be detected by the tests mentioned, and loss prevented.

Sands for brass molding and light castiron requiring nickel or other plating should be fine enough to provide the required finish or surface to the casting.

For these a smooth, shiny surface of the casting, when shaken out of the mold is not harmful. But, in the production of light work, requiring enameling or japanning, it is desirable that the sand be sufficiently open in grain to allow a grip for the material on the surface of the casting.

At no time should sand be so fine that the flow of the metal is shown on the surface, indicating a silty condition.

AIR DRIED SAND

A very common error in a foundry, when increasing the number of floors run, is to start up an old heap of sand by simply wetting it and cutting it over.

This practice always results in loss of castings and poorly finished product.

Sand which has become air-dried cannot be tempered in a few minutes' time. The best method is to distribute the old heap among the other heaps which are being used, and replacing it by withdrawing sand from the tempered heaps.

SCRAP

Crushed Work may be traced to any of the following causes:

Misfit cores.
Heavy clamping.
Misfit jackets.
Overcrowded patterns in flask.
Careless shifting of weights.
Crooked weights.
Crooked tops of molds.
Crooked press boards or platens.
Short core bearings.
Core prints too close for core-ends.

Shaving of sand on ends of core in closing.
Loose, wabbly guide pins.
Weak sand.
Improperly secured cores.
Crooked pattern plates.
Gaggers (where used) projecting.
Loose flask bars (floor work).
Patching of molds at partings.
Rough handling of molds.

Blowed Work may be caused by any of the following conditions:

Improperly tempered sand.
Too much new sand.
Too fine close grain sand.
Too strong facing sand.
Too much sea-coal in sand.
Hard ramming of close sand.
Sponging or swabbing of sand.
Cores too close in grain.
Cores too strong in binder.
Improperly tempered core sand.
Cores not dry.
Excess gases from binders in core.
Cores with hard glazed surface.
Cores improperly vented.
Misfit cores allowing iron in vents.
Pocketed gases in cores.
Excess use of oil, resin, flour, pitch or other gas making materials used for binders.
Rusty chaplets.

Wet chaplets.

Use of uncoated nails as chaplets.

Chaplets coated with high lead percentages instead of tin.

Chaplets made from terneplate instead of tinplate.

Rusty, uncoated, cold, wet or improperly coated chills.

Use of sands in molds or cores, too fine, close or strong, unsuited to character of work to be cast.

Slag in Castings may be traced to any of the following conditions:

Metal melted too cold, not allowing thorough separation of dross from the metal.

Non-fluid metal, through lack of the elements which assist fluidity is easily oxidized.

Force of flow of metal into the mold through lack of proper checks.

Wet sand or improperly tempered sand, which serves to create a boiling action in the metal while entering the mold.

Very often small, bead-like holes are found on the outer surface of castings, after cleaning, the origin of which it is sometimes difficult to solve.

If these castings are examined before cleaning, there will be found numerous black spots along the flow of the metal, which if examined closely, will be found filled with a cinder-like slag, that invariably will be attributed to the metal.

As a matter of fact, these so-called slag holes or slag spots are originated in the mold itself in various ways—sand too fine or silty being picked up by the flowing metal.

Iron boiling in the mold caused by excess moisture in the sand or too much new wet sand being used will cause these spots.

Force of the flow of metal through too small a runner as through a hose nozzle, having a tearing action in the mold, creating a scabbed surface along the flow and farther on where this fine material has been carried creates a similar class of pinholes.

These are very often confused with the small holes occurring in the heart of the metal, caused by occluded gases.

Occasionally sands which are too fine in grain for the class of castings being made will fuse at or close to the runners, creating a slag which causes spots along the flow.

With proper forms of gating, the real slag from the iron, especially if the iron is hot enough to free itself from the slag, seldom shows in the casting. Iron will always free itself from this slag if it is hot enough and fluid enough.

Skimming the metal as it is poured into the mold means but very little in stopping the pinholes or slag holes. *These are created inside of the mold.*

The use of uncoated wrought iron nails, chaplets, exposed rods, rusty chills, etc., will create so-called slag holes, caused by the fusing of the metals low in carbon and unable to resist the higher temperatures of the molten metal.

Strained and Swelled Work are generally the results of the following causes:

Overcrowded patterns.
Weak sands.
Misfit mold jackets.
Light mold weight.
Improper clamping of molds.
Uneven ramming or pressures.
Hard pouring.
Misfit cores, smaller than the core prints, invariably cause a swell at the point of contact of the core and the mold.
Patterns set on plates too close to each other where the runners are uneven and allow one casting to fill ahead of the other represents a prolific source of swelled castings.
Burned out bottom boards are a constant source of run-outs and swelled castings.
Steel flasks of too light construction.

When iron bands are dropped into the flask and left in the mold, bands are sometimes forced into the flask, and when it is removed the band springs away from the mold, allowing casting to swell.

Run-outs may be caused by

Patterns crowded too close to flask.
Light weights on the mold.
Insecure clamping.
Corners of mold broken in removing flasks.
Weak sand.
Burned bottom boards.
Too hard pouring.

Crooked mold jackets.
Flasks not properly closed.
Crooked or worn strike-offs.
Over-venting of molds.
Misfit cores—too large fin.

Mis-run or coldshut may be caused by

Cold metal or non-fluid metal.
Careless pouring.
Wet molds.
Resistance of flow by gases.
Excess binder in cores.
Sand too close in grain.
Runners or gates too small.

Shrinkage, or in other words, unequal contraction, is invariably caused by the construction of the patterns with light sections adjoining the heavier parts, without allowing an even distribution of the metal, the lighter parts cooling first, naturally draw from the heavier and where the strain is the greatest, in the sharp angles, a cavity is invariably found.

A great many of these defects might be avoided if in designing the patterns, sharp angles were avoided and fillets used, and if possible, gradually grading the metal thickness, tapering from the heavy section to the light section.

Where the sharp angles are absolutely necessary, the shrinkage may be avoided by using chills in the angles.

A constant source of shrinkage in some lines is caused by over-zealousness in cutting down flask depths.

Many instances of shrinkage may be avoided by building up the height of the sprue or gate-stick by use of a runner box, 3 to 5 inches above the top of the mold, increasing the ferro-static pressures.

There are several forms of shrinkage caused by the metals. In heavy sections of castiron where the cooling is exceptionally slow, very often *Kish* or a separation of graphite carbon occurs in flakes, accompanied by a fibrous formation of shrinkage, this is directly the opposite of shrinkage occurring in in low carbon metals, malleable hard iron, etc.

These are mainly questions to be solved by the metallurgist.

BROKEN WORK

Every foundry has its own problem to solve in this form of loss. Rough handling—mills not packed tight enough—heavy castings milled with light, etc.

In the foundry, dumping the molds too soon and rough use of hammers is a continual source of breakage. Very seldom is this form of loss due to any molding cause. Sometimes the construction of the pattern may cause breakage in contraction.

Sometimes runners are attached in such a manner to light work as to cause breakage by contraction in the runner bars.

This should be the lowest form of loss in the foundry, but through neglect or oversight it will be found to be considerable in a year's time in any foundry.

When broken work is reported it should be traced to the source immediately, being a physical cause for loss.

CORES

Very often it occurs that cores do not stand up to the effect of extremely hot metal, which appears to eat into the core and occasionally small flake-like pieces pop off the core and cause defects in the castings.

Generally this is attributed to weak cores and the oil or other binding material is blamed, which when increased, only aggravates conditions, causing blow and coldshut castings.

The real cause of the trouble is the substitution of a finer grain sand which lays closer and does not allow free escape of the gases, hardens very easily on the surface and peels easily. Blacking the cores sometimes gives temporary relief but the cause should be removed.

SANDOLOGY

There is plenty of room for thought on the part of the student of Sandology.

Why do some sands fuse so easily to the casting, while others fall away free, leaving a finish like silk?

Why do some sands form a perfect scale which peels from the casting while others simply go up in a cloud of dust when the mold is dumped?

Is the base of the bond in some sands in the nature of a flux which acts upon the silica, when the heat of the molten metal strikes it? Is it similar to the action when fluorspar or oxides which are used in excess in melting and their effects upon the lining of the furnace or cupola.

The bonding material of molding sand being exceedingly fine, what is its real effect upon the finish of the casting?

Why do some foundrymen prefer red sands and others yellow sands?

What is the nature of the material and its effect on different classes of castings, which cause them to prefer either?

What do chemical terms of sand mean to the man in the shop in making his molds—Si-O2 (Silica Oxide) represents the silica in his sand, but in a changed condition to suit the laboratory measurements. How can he connect this with his losses?

AL_2O_2, Aluminum Oxide—the same.

FE_2O_2, Iron Oxide—How will he recognize the effects of this in his scrap.

CA_1O, Calcium Oxide—What influence has calcium in any form upon the casting?

True, a pebble of limestone gravel in the sand may crack or explode under heat and create a defect in the casting, but if it is in the form of a powder (as in the bond), what possible effect may it have on the casting, and how can the foundryman discern its effects?

Mg.O, Magnesium Oxide—percentages always classified in chemical analyses of sands. What connection has this material with the sand which would cause or prevent loss?

Ca-F2, Calcium Fluoride—What possible connection outside of gases generated could this material have with the causes of loss?

If the analyses of molding sand is to be of any value to the foundryman or his assistants, it must be brought to some simple form of explanation, which anyone may understand and not in the formulae and chemical symbols which are so confusing to anyone not having had a chemical knowledge.

The foundryman also has many terms which he uses that are just as confusing to the chemist, and he does not hesitate to use them, if by so doing he may outwit the other fellow. A little "get-together" would simplify matters greatly.

MOLDING SANDS

Molding sands are mined in almost every part of the United States. Other sands containing little or no bond are also mined for foundry use, in the making of cores, for furnace linings, sand blasting, etc.

Presented herewith are descriptions of a few specimens of sand from all parts of the Country, most of them being used for molding purposes. Some of them are shown simply to demonstrate the *wide range of observation* and study of sand which may be made by the use of the *Vibratory Test.* They do not necessarily represent *all* of the sands mined in the States mentioned.

The opinions expressed are only meant to apply to the specimens as taken, and the *figures given* showing the amount of *bond* and *silica,* as *separable by water,* are meant to show that it *IS possible* to measure sands and their divisions and express them in figures, also to determine their fitness for the various lines of molding, by observation of the grain variations, both for fineness and by their color determining other characteristics.

It is also possible by the same method to determine the changes which take place, after the material has been subjected to the temperatures and conditions of the various grades of castings produced in the foundry.

Having records covering several years of practical foundry application and the examination of thousands of tests made, the writer is firmly convinced that the Vibratory Test has furnished us a dependable means of examining our sands, both new and from the heap and *expressing their values in figures,* sufficiently dependable to govern our losses, also to communicate with each other in figures of a simple form and in discussing their values whether in the foundry or at the pit.

In giving descriptions of the various sands, the writer will try and follow the general geographical location of their source and where molding sands are recorded as having been mined and no specimens have been taken or received, extracts from Bulletin 624 United States Geological Survey of 1917 will be given, showing by counties where molding sands are procured.

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ALABAMA

ROUND MOUNTAIN SAND   VIBRATORY TEST
Cherokee County   Bond, 36.84%; Silica, 63.15%
COLOR: RED

This is a splendid grade of open sand, with a strong bond suitable for all grades of light machinery castings. Having a medium fine grain and a very even texture, it should provide a good finish and wear well. This sand and the Gadsden sand from the adjoining County, Etowa, should work well together and give a good control of the sands in use—one as an opener and the other as a strengthener.

GADSDEN SAND
Etowa County
COLOR: YELLOW

VIBRATORY TEST
Bond, 65.62%; Silica, 34.37%

This sand is mined in the northeast section of Alabama and like many other good molding sands has its origin in the Lookout Mountains. It is a very strong, medium grained sand, suitable for ordinary heavy bench work, soilpipe, fittings, etc., and similar work where the sand is subjected to severe usage. On account of its high bond it should be worked in conjunction with a high silica sand to avoid losses from blowed work, etc. New sand additions to the heap should be carefully watched to avoid losses and only added in small quantities.

TRUSSVILLE NO. 1
Trussville, Jefferson County
COLOR: VERY LIGHT YELLOW

VIBRATORY TEST
Bond, 25.00%; Silica, 75.00%

This is a fine strong open sand having a most peculiar shade of light creamy yellow. This particular shade of sand is the only one of its kind among several hundred specimens of fine sand from every section of the country.

It has a very sharp abrasive texture, similar to the Windsor-Lock sand of Connecticut and appears almost as if it were artificially crushed from a very even-grained sandstone. It should prove an excellent sand in the casting of aluminum.

A California Pioneer

TRUSSVILLE NO. 3 **VIBRATORY TEST**
Saint Clair County Bond, 36.00%; Silica, 64.00%
COLORS: DARK RED

This specimen, tested although extremely fine, is the direct opposite of the No. 1 Trussville. This is an extremely close sand and it is doubtful if it could be used for any form of castiron, unless combined with a heavier grade. The grain size is very even with the exception of a layer of silt showing in the test.

Molding sands are also mined in the following Counties of Alabama—Clark, Elmore, Grandview and Jones.

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ARIZONA

No records or specimens received of molding sands from this State.

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ARKANSAS

Molding sands shown by bulletin as mined in Johnson and Pulaski Counties, but no specimens have been tested.

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CALIFORNIA

Bulletin shows molding sands mined in Alameda County at Centerville and DeSoto, also in Monterey, Orange and San Diego Counties.

The California foundrymen manufacturing in large quantities have been greatly handicapped in procuring the most desirable grades of sand, both on account of excessive freight rates from the East and the proper development of local deposits, which no doubt exist in the vicinity of the Rockies and which unquestionably will be brought out by future surveys and demand.

Several very good grades have been mined in the vicinity of Riverside, Riverside County. The Southern California or San Diego sands are generally of very fine grain and the Northern sands are too high in bond.

A great deal of sand is brought into California by water, through the Panama Canal from the East and considerable is brought in from Belgium. The smaller foundries have had to be content with such materials as could be procured from local excavations.

LOS ANGELES—BENCH SAND

Riverside County VIBRATORY TEST
COLOR: DARK RED Bond, 47.05%; Silica, 52.49%

The specimen of this sand submitted shows an excellent grain size of even texture. This is an open sand with a strong bond and has been adopted by many of the Los Angeles foundrymen as a standard sand. It is identical in texture with one of the best Ohio No. 2 sands and is used for light machinery, floor and bench work. It should wear well and give an excellent finish to castings.

LOS ANGELES—FINE SAND VIBRATORY TEST
Riverside County Bond, 25.00%; Silica, 75.00%
COLOR: DARK RED

This sand is from the same vicinity as the Bench Sand, but the Vibratory Test shows it to be much more open, with but slight difference otherwise. If used alone, it should stand heavy ramming or pressures. It would work splendidly as an opener for the bench sand, if required. Alone, it would be a very useful sand on all classes of light hardware, requiring a smooth finish and work to be enameled, japanned or plated.

VIBRATORY TEST
SILICA ROCK SAND Bond, 25.00%; Silica, 75.00%
Coyote Wells, Imperial County

This remarkable specimen is not of any practical use for molding purposes. When vibrated this sand would seem to demonstrate the formation of the cement-like bond which occurs in nature. The Vibratory Test when made shows a division of Bond, 25%; Silica, 75%. After standing for a week or two, the low percentage of alumina—3.3% barely tinges the fine cottonlike bond, with a yellow shade and the iron in this specimen gives no other color indication of its presence. When the specimen bottle is twirled with a circular motion back and forth, the bond rises in the water with a light cottonlike movement. This formation of bond would seem an indication of bond in nature's making.

Silica	85.6
Alumina	3.3
Iron Oxide	.7
Lime	2.2
Magnesia	.75
Alkali	2.2
Loss on Ignition	4.8
Comp. Fineness	40.

Chemical Analysis

These terms are given in connection with this specimen only because of its peculiar nature.

The foregoing description is only given as an object lesson for any student who cares to study the disintegration of rock and the effect of water and vibration and this together with his study of calcite in nature will give him plenty to think about.

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CONNECTICUT

VIBRATORY TEST

WINDSOR LOCK SAND Bond, 19.2%; Silica, 81.2%

Windsor Locks, Hartford County.

This is a wonderful fine sand of granite rock origin. It has a high heat resistance but on account of its extreme fineness it cannot resist the flow of metal without spraying and skin-drying.

It makes an excellent opener for French sand (unprepared) and is extremely useful in casting bronze and fine art work.

This sand is also used for an entirely different purpose. In the machine shop for the lapping of seats in brass valves, etc., on account of its abrasive qualities it makes an excellent finish.

Its extreme fineness also makes it useful in the casting of gold and silver.

Molding sands are also mined in Connecticut at New Britain, Hartford County, although no specimens have been obtained.

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COLORADO

Bulletin gives molding sands as dug at Denver and Pueblo, but no specimens have been obtained.

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DELAWARE

Bulletin shows molding sands as dug in Christiana, New Castle County.

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GEORGIA

This state, like Tennessee and Alabama, has many deposits of molding sands which are not as yet fully developed. These deposits have their origin in the mountains and along the various rivers and the sands are principally mined in the northern parts of the State. Almost all of the Georgia sands are of a dark red color, showing the presence of iron.

The bulletin gives locations of molding sand deposits in Georgia at Ringold, Catoosa County, Chickamauga Creek; Elligay, Gilmer County, Carteeny River; Demorest, Habersham County, Branch of Chattanooga River; Almon, Newton County, Yellow River; Howard, Taylor County, White Water River, and Flintstone Walker County, West Fork of Chickamauga River.

It is safe to predict that this part of the country will become another great foundry center of the future. Having iron, coal, limestone, etc., it naturally follows that molding sands will become an important product.

ROADSIDE CLAY VIBRATORY TEST
COLOR: DARK RED Bond, 37.50%; Silica, 62.50%

The specimen tested is very common in this part of the State. Having every appearance of being a good molding sand, it is shown merely to demonstrate its *unfitness* for molding. It has a bond strong enough for the heaviest of molding sands and a grain fine enough for light brass work. Ninety per cent of this sand would pass through a 100 mesh sieve.

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ILLINOIS

Excellent molding sands of every grade of bond, silica and fineness exist in almost every county in this State. Most of the fine sands are found in the northern and central parts of the State and heavier grades in the south.

VIBRATORY TEST
ROCK RIVER SPECIAL Bond, 40.00%; Silica, 60.00%
Rockton, Winnebago County

This is an extremely fine sand of very even texture. It is very strong in bond and free from silt. It should prove very useful for brass, light castiron, plated work, etc. It should give an excellent finish to the castings, but it is not wise to use it alone on account of its excessive bond. It would be useful where fine sand is weakened by core droppings in the heap. If used alone for castiron it will not stand hard ramming or pressures or excess moisture and would require extreme care to avoid blow, coldshut, etc., in pocket work.

JOLIET SAND — VIBRATORY TEST
Will County — Bond, 78.37%; Silica, 21.62%

A plentiful supply of this extremely strong bond sand is found surrounding Joliet. Great care must be taken in selection on account of its high lime content, this being a limestone region. Sands from this district are largely used in steel works for daubing and cupola clays. The grain of this sand is generally of excellent fineness, but on this account, as well as because of its very high bond, it will not stand hard ramming or pressures. It cannot be used alone for molding purposes, but makes an excellent binder for sand which has become weakened by excess core sand or sea-coal.

VIBRATORY TEST
ROCKDALE SAND — Bond, 28.57%; Silica, 71.42%
Rockdale, Will County
COLOR: RED

This is a splendid open grain strong bond sand, suitable to all classes of general bench molding and squeezer work. It is of very even texture, should give excellent finish to the castings and wear well. This deposit, ranging in depth from two to six feet, is very peculiarly situated, being on top of a gravel deposit rising above the roadway from thirty to sixty feet and about one-quarter of a mile in length at Rockdale, Illinois, along the Joliet highway. This deposit is not being mined at present on account of difficulty in providing economical railroad facilities. A visit to this region will at any time prove interesting to the student.

VIBRATORY TEST

ELWOOD NO. 4 SAND Bond, 46.66%; Silica, 53.34%
Elwood, Will County
COLOR: RED

This is another excellent molding sand from the Joliet district, Elwood being situated about ten miles south of Joliet on the State Road to Springfield. This deposit is not very large, covering possibly from twenty-five to thirty acres. It is an excellent medium-grained sand with a strong bond and should prove useful for all classes of medium work, machinery castings, bench work, heavy hardware, floor work, etc. As with all other sands from this region, care should be taken to avoid excess moisture, also too strong additions at one time to the heap.

VIBRATORY TEST
Bond, 47.17%; Silica, 39.62%; Silt, 13.20%

RED MEAL
Rockton, Winnebago County
COLOR: YELLOW

This is a medium fine grained sand with an exceedingly strong bond for so fine a grain. It should prove a useful sand for light bench molding of cast-iron, but great care will be needed in using on account of its strong bond. It should prove a great strengthener for sands which are weakened by excess core droppings. Heavy pressures or ramming should be avoided.

VIBRATORY TEST

REDWARE Bond, 37.83%; Silica, 62.16%

Rockton, Winnebago County

This is a fine grained sand, suitable for brass and non-ferrous metals or extremely light castiron. It should be guarded against hard pressures or ramming and excess moisture. It is very even in texture and should give an excellent finish to the castings.

VIBRATORY TEST

HARDWARE SAND Bond, 47.61%; Silica, 52.38%

Rockton, Winnebago County

This is a fine grain, strong bond sand of very even texture, useful for light hardware and brass castings. It is a good strengthener for weakened heaps, but care should be exercised in its use by adding the new sand in very small quantities. If used alone in castiron, this sand would not stand excessive pressures or ramming. It should give an excellent finish to light castings.

VIBRATORY TEST

GALENA SAND Bond, 24.13%; Silica, 75.86%

Galena, Jo Daviess County

A very fine grain sand of even texture, suitable for very light castiron hardware or brass. It should give an excellent finish to the castings and wear well, but if used for castiron, excess moisture, hard ramming or pressures should be avoided.

Vibratory Test
No. 1 Galena Bond, 19%; Silica, 68%; Silt, 13%
Galena, Jo Daviess County

This is a medium heavy grained sand with sufficient bond for the grain. It has a very even texture, open grained and is useful for light floor work, bench or press, light machinery, castings, etc. It should give an excellent finish to the castings and will stand fairly hard ramming or pressures.

The silt present would cause no particular harm in general castings, but care must be taken if used on castings requiring high pressure tests.

Vibratory Test
No. 1 Cowboy Bond, 19.00%; Silica, 81.00%
Galena, Jo Daviess County

This is a beautiful specimen of fine sand, common to the Northwest section of Illinois. It has a fine grain, an even texture and is free from silt. It is useful for light hardware and non-ferrous metals. On account of its low bond and character of grain, this should prove a good sand for aluminum work where hard ramming is required. In light castiron it would be advisable to have a stronger bond sand for renewal.

NO. 1 HIX SAND VIBRATORY TEST
Dixon, Lee County Bond, 40.00%; Silica, 60.00%

This is a medium heavy grained sand with a very strong bond. It is useful for all grades of bench and light floor molding and should give an excellent finish to the castings. If used alone, care must be taken to avoid adding large quantities to the heap at one time on account of its high bond. This is a very useful sand as a strengthener for heaps which have been weakened by excess core droppage.

VIBRATORY TEST
NO. 2 MULBERRY
Bond, 52%; Silica, 48%
Mulberry Grove, Fayette County

This is a medium fine grain sand having a very strong bond. It is a good bench molding sand, but should be used with a more open grain sand for best results. It should prove a very useful sand where a strengthener for weakened heaps is needed.

NO. 4 ARENZVILLE VIBRATORY TEST
Arenzville, Cass County Bond, 45%; Silica, 55%

This is a medium fine sand, even grained and of a very strong bond. It should prove useful for bench and light jobbing work but great care must be taken to avoid excess additions of new sand to the heap on account of its high bond. This is a good sand for light work where cores are used.

NO. 3 ARENZVILLE VIBRATORY TEST
Arenzville, Cass County Bond, 48%; Silica, 52%

This is another specimen of the same grade of sand as Arenzville No. 4 but stronger in bond than this particular grade. It should prove a good sand for renewal of weakened heaps, but should be used sparingly.

NO. 1 TAMALCO VIBRATORY TEST
Tamalco, Bond County Bond, 54%; Silica, 46%

This is a very heavy grained, red sand, with strong bond. Should prove suitable for heavy machinery and bench work where the sand receives severe usage.

Being so extremely high in bond, unless there is a large quantity of open core sand droppings, it should be used in combination with a more open sand.

NO. 1-A TAMALCO VIBRATORY TEST
Tamalco, Bond County Bond, 37%; Silica, 63%

This is practically the same as the No. 1 Tamalco with the exception that it is a more open sand and has less bond but the proportions are satisfactory for the class of work this sand would be used upon.

VIBRATORY TEST
NO. 7 GREENUP Bond, 15%; Silica, 85%
Greenup, Cumberland County

This is a very even grained open sand, excellent for all around general castings, agricultural, carriage hardware, etc., in the heavier lines. This sand shows two divisions of the silica. The main portion about 75% (silica) is yellowish brown in color and a small band of fine silt, about 10% (also silica) which is a very dark brown. This amount of silt is not enough to cause any particular harm. This sand should make a good opener for any class of work, with good wearing qualities.

VIBRATORY TEST
PURITY NO. 1-O Bond, 30%; Silica, 70%
Dallas City, Hancock County

This is a very fine grain strong bond sand of very even texture, suitable for brass or very light castiron bench work.

VIBRATORY TEST
PURITY NO. 1 Bond, 27.50%; Silica, 72.50%
Dallas City, Hancock County

This sand is almost identical with Purity No. 1-O but slightly finer in grain and lower in bond. It is useful for non-ferrous metals and very light castiron.

VIBRATORY TEST
PURITY NO. 2-O Bond, 46.34%; Silica, 36.58%
Dallas City, Hancock County Silt, 17.07%

This is a medium grain sand, suitable for light castiron, stove plate, carriage work, etc., but owing to the presence of about 20% of fine silt, in the silica portion of it, it would not be advisable to use for castings requiring air or water tests.

VIBRATORY TEST
PURITY B-O Bond, 16.66%; Silica, 83.16%
Dallas City, Hancock County

An excellent fine grained, open sand, with a strong bond and very even texture. Suitable for light castiron, stove plate, auto work, etc., also all classes of work requiring plating or extra fine finish. It should prove a good sand for aluminum work.

VIBRATORY TEST
ALGO SAND Bond, 37.50%; Silica, 44.44%
Algonquin, McHenry County

This is an open strong, medium fine grained sand, suitable for all grades of bench molding and press work. It is a good strengthener for weak sands but when used alone, care must be taken against excessive additions to heap.

VANDALIA RED
Greenville, Bond County

This is a coarse open, strong sand, suitable for heavy machinery floor and jobbing work. It will stand hard usage, but excess moisture must be avoided. This is a reddish yellow sand, showing a small dark band of silt of about 8% which is not enough to be harmful.

BUFFALO ROCK VIBRATORY TEST
Ottawa, Illinois Bond, 16%; Silica, 84%
YELLOW SILICA

This sand is of a very refractory nature and should be useful in steel facings, where a finish is desired. At first glance in the Vibratory Test, it would appear to have a very heavy bond for so fine a sand, but upon closer observation it will be seen that nature has not completed her work and the bond is very light and cottony in appearance.

The only other specimen of this character among the writer's collection, comes from Coyote Wells, San Diego, California.

SILICA SANDS

1. Magnesia
2. No. 1 Sand
3. No. 2 Sand
4. Abrasive Sand
5. Mine Run Sand
6. Crude Sand

The silica sands of the Ottawa district have a world-wide reputation in the glass industry. Some grades are used in the manufacture of fire-brick, tile and for furnace work. A great amount is used too, in steel molding, also for sand blasting and many other purposes.

Numerous statistics may be obtained on these sands in any Technical Library and are only mentioned here as an Illinois product and a part of the collection.

CARPENTERVILLE NO. 2 SAND

Carpenterville, Ill. VIBRATORY TEST
Bond, 51.72%; Silica, 47.27%

This is a medium grained sand of about the same character as Beloit, Davidson, Holmes, Elwood and other No. 2 Illinois sands. It has a very strong bond and is suitable for general conveyor work.

"BONDIT" VIBRATORY TEST
Bond, 86%; Silica, 14%

This is a prepared material containing a natural bond of very high colloidal nature. It is extremely fine in grain providing a natural finish to the castings made in heavy grained sands.

Great care must be taken to avoid its use in excessive quantities and it is very essential that it be thoroughly blended through the heaps.

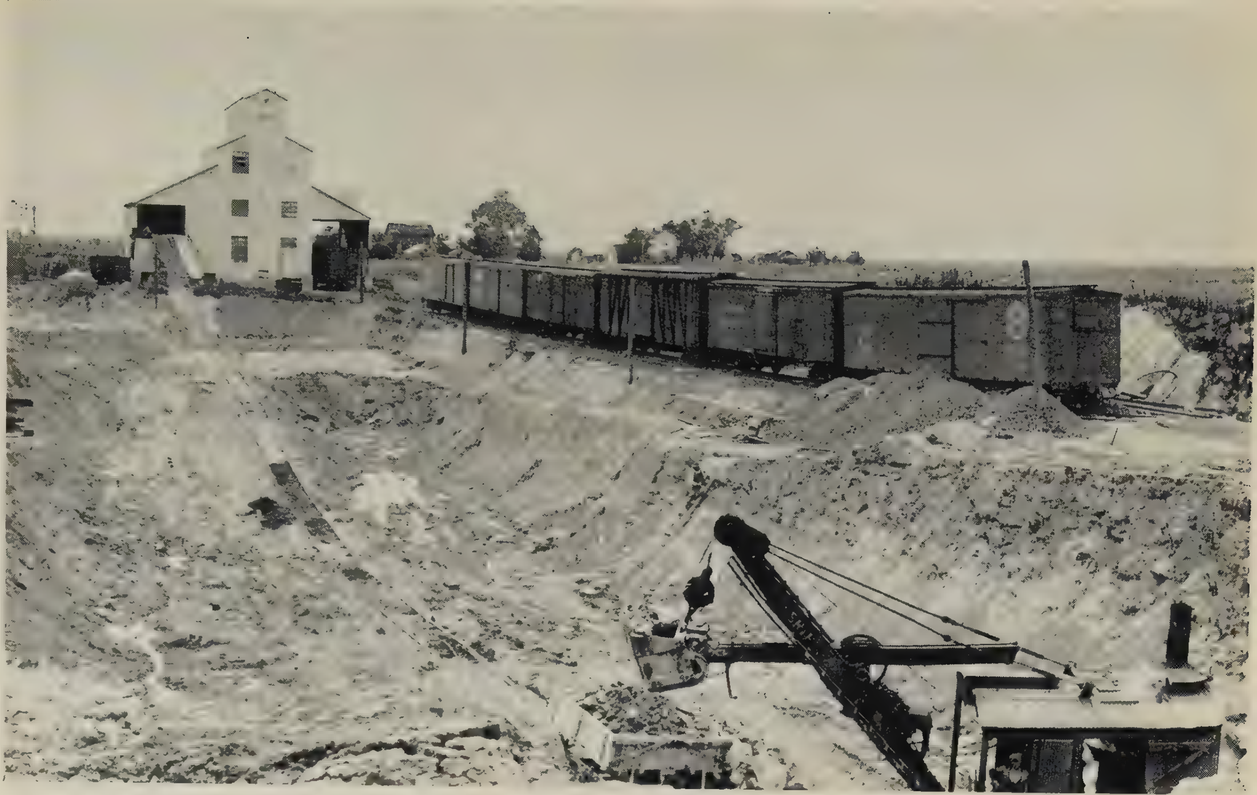
Careful intelligent use of this material in a weakened or worn out heap will immediately revive it and will result in an immediate reduction of loss.

GOOSE LAKE VIBRATORY TEST
Grundy County, Ill. Bond, 38.5%; Silica, 61.5%
COLOR: DARK BROWN

A strong medium grained sand, suitable for bench, press and light floor work, machinery castings, general light jobbing work, etc. This sand is a good strengthener for worn heaps, but care should be taken in its use to avoid excess moisture or excessive additions of new sand to the heap at one time. This sand shows a slight trace of silt, less than 6%, which is not enough to be harmful on ordinary work.

STERLING FINE SAND VIBRATORY TEST
Sterling, Ill. Bond, 45.45%; Silica, 54.54%

This is a strong fine sand, suitable for very light hardware, malleable and castiron and brass castings. Care must be taken in its use on account of heavy bond. This sand is similar in character to the Rock River Sands.



An Illinois Clay Deposit—Showing Mine Activity

NO. 2 MEDIUM VIBRATORY TEST
Carpenterville, Ill. Bond, 50.00%; Silica, 50.00%

This is a splendid grade of Illinois No. 2 sand. It is of very even texture, medium grain and suitable for all grades of light machinery castings, agricultural, bench and floor work.

It should wear well and stand hard usage. It is a good strengthener for weakened heaps but excessive use at one time must be avoided. It should prove a good sand for use where heaps are weakened by excess core droppings.

NO. 3 HEAVY VIBRATORY TEST
Carpenterville, Ill. Bond, 55.88%; Silica, 44.11%

This is an extremely strong bond, medium fine grain sand, of very even texture. There is no silt present. This sand should prove a good strengthener for weakened heaps, and is suitable for all grades of medium castings, bench and floor work, agricultural hardware and machinery castings.

Care must be taken in using this sand on account of the strong bond and it is well to avoid use of excessive quantities. It should wear well.

ROSEDALE—MEDIUM VIBRATORY TEST
Rosedale, Ill. Bond, 42.10%; Silica, 57.89%

This is a splendid specimen of heavy brown sand. It is very even in texture, of medium fine grain and suitable for all grades of medium heavy castings, malleable castiron, agricultural and machinery castings. It should wear well and give good finish to general castings. It has no silt and no lime, and will stand hard ramming and pressures.

RED TOP HEAVY VIBRATORY TEST
Keyesport, Ill. Bond, 54.28%; Silica, 45.71%

This is a medium heavy grain, strong bond sand, suitable for all classes of medium heavy floor work and heavy bench work. It should wear well and stand hard ramming and pressures. Care must be taken in using on account of the heavy bond content. There is no lime present and just a trace of silt.

It is a good strengthener for heaps subject to hard usage.

There are a great many more good molding sands mined in Illinois, which might have been noted if test records had been made.

The general tendency of Illinois sand seems to be to run high in bond and when using Illinois sands, consideration should be given to this fact.

It might be well to mention here that Northern Illinois, Eastern Wisconsin and Western Michigan, all in the Lake Region, can furnish an unlimited supply of core-sands, having a natural bond content from 5 to 12%—so-called bank sands. These sands are of a very even texture and the core droppings in the heap furnish an excellent foil for the excess bond in such molding sands.

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It is perfectly safe to estimate that 50% of the casting losses in Illinois foundries can be attributed to using too great quantities of new sand in the heaps, increasing the bond content faster than it is burned out or weakened by core-sands, then of course, when trouble does occur its use is stopped altogether until a corresponding loss is caused by weakness.

There is only one practical way to control this condition and that is to *test* the heap sands each day for bond content and increase or decrease it as found necessary, this in turn to be governed by the scrap or losses.

Several good grades of fire-clays will also be found in many districts of Illinois.

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INDIANA

Indiana has a plentiful supply of good molding sands of every known grade and suited to all grades of castings, from the lightest of hardware to the heaviest machinery castings.

In the northern part of the State or the Lake Region, the more open grained sands abound.

In the southern section, along the Ohio River, the finer grades occur.

Plentiful deposits of the heavier grades exist along the Wabash River, almost its entire distance, from Logansport south to where it empties into the Ohio River.

Numerous deposits occur along the White River in the vicinity of Terre Haute and farther south. There are also deposits along the East and West forks of the White River, so far North as Indianapolis.

Many excellent deposits of fine sands occur along the Ohio State line and in the Whitewater Valley.

DYETON SAND

COLOR: DARK YELLOW VIBRATORY TEST

Bond, 47.36%; Silica, 52.64%

This is an exceptionally good grade of fine sand, and is splendid for light bench work. It is a reasonably open and strong sand and should be suitable for ordinary ramming, but not high pressures. It should wear well and give a smooth finish to the castings. This grade of sand is plentiful on both sides of the Ohio River in Indiana and Kentucky. Although a little strong in bond, it compares favorably with the New York sands of the 00 grades, but of course, it is not of the same color or chemical character. It is very useful for light carriage work, auto trimmings, light hardware, typewriter castings, name plates and such work as requires japanning or plating.

The finish of the castings when this sand is properly handled should be the equal of that made in the famous "French" sands. A name written on an ordinary card with a pencil may be reproduced.

This sand is absolutely free from lime.

NO. 1 LUCE TOWNSHIP VIBRATORY TEST

Spencer County Bond, 24.24%; Silica, 75.75%

COLOR: LIGHT BROWN

This is a beautiful open fine sand and should prove an excellent sand for brass and aluminum work. Very uniform in grain. This sand would be extremely close for castiron and should only be used on extremely light work.

T-5 TROY — VIBRATORY TEST
Perry County — Bond, 33%; Silica, 67%
COLOR: BOND—DARK YELLOW
SILICA—BROWN

This is a medium heavy grain, strong open sand, and should prove suitable for general casting, bench, floor and machine molding.

A-1 SANDALE — VIBRATORY TEST
Spencer County — Bond, 29%; Silica, 71%

This is one of the few fine sands, having no excess bond. It should prove an excellent sand for light novelty work or aluminum. It should wear well and give excellent results where plating is required.

A-1 SANDALE—OPEN — VIBRATORY TEST
Spencer County — Bond, 25%; Silica, 75%

This sand carries all of the characteristics of the A-1 Sandale sand but has a slight advantage in that it carries a slightly less bond.

SPECIAL 00 SANDALE — VIBRATORY TEST
Spencer County — Bond, 30%; Silica, 70%

This is a strong bond, fine sand, suitable for stove plate and light hardware. It is a good sand for brass work, but for aluminum a more open sand combination would be required. Care should be taken to avoid wastage by adding to the heaps in too large quantities. It should wear well but excess moisture must be avoided.

DIAMOND H SANDALE
Spencer County

A strong bond, fine sand of about the same texture as the Special 00 but a little more open. It is suitable for stove plate, malleable, brass and light hardware, requiring plating, enameling, etc.

NO. A-B SANDALE VIBRATORY TEST
Spencer County Bond, 25%; Silica, 75%

This is a medium fine sand, suitable for light bench work, machine molding or brass. It should stand ramming and pressures and wear well. This sand compares favorably with the best of Indiana or Kentucky fine sands and should give an excellent finish to the castings, but care must be taken not to add to the heaps in excess.

VIBRATORY TEST
WANETAH SAND Bond, 24%; Silica, 76%
Wanetah, LaPorte County

This is an extremely open sand of very even texture and medium grain. It is one of the most useful sands in the country, particularly in the surrounding States, where the average molding sands are too high in bond. It is valuable as an opener for facing sands and may be used on any class of work from one pound castings up to 500 pounds. It would be too fine in grain for heavier castings than 500 pounds.

Southern Indiana Deposit in the Ohio River Valley

This sand is also especially adaptable for radiator work, boiler sections, water backs or any class of work where the gases are excessive in the mold and require quick relief. As this sand alone weakens very easily, great care must be taken to keep up the bond content in the heap.

It is particularly valuable in pocket work and will stand extremely hard ramming or pressures without harm to the casting. It should be worked in conjunction with a high bond sand for best results. It should not be used in excess on the heavy lines of work on account of its weakening effect on the heavier grained sands.

NO. 5 LUCE TOWNSHIP VIBRATORY TEST
Spencer County Bond, 30.90%; Silica, 69.09%
COLOR: DARK BROWN

This is a strong open medium grain sand, having a composite fineness of 29%. It is an excellent sand for heavy bench or floor molding. This sand should give an excellent finish to the castings and wear long.

NO. 1½ LUCE TOWNSHIP VIBRATORY TEST
Spencer County Bond, 44.73%; Silica, 55.26%
COLOR: BOND—YELLOW
SILICA—DARK YELLOW

This is an extremely fine sand, suitable for brass and non-ferrous metals only. It has a very even grain and should give excellent results where detail in the casting is required.

NEW ALBANY VIBRATORY TEST
Floyd County Bond, 24.48%; Silica, 75.51%
Local Sand, Specimen not graded
COLOR: DARK BROWN

This is a heavy open grained, strong sand, suitable for very heavy machinery and the rougher forms of floor work. In its natural state it is very strongly impregnated with light gravel and care should be taken to avoid trouble from the latter by screening this sand before using. It should prove a long-wearing sand with decided advantages in small jobbing foundries.

VIBRATORY TEST
BRADFORD SAND Bond, 30.76%; Silica, 69.23%
Centerton, Morgan County
COLOR: LIGHT BROWN

This is a splendid grade of medium heavy grain, open and strong sand. It is suitable for heavy bench molding, also floor work, general machinery and car work, when used alone. It is a little too coarse for light castings where a finish is required. It is an excellent opener for prepared facings for use on castings up to eight or nine hundred pounds. The wearing qualities are excellent and it should work well in combination with Illinois or Wisconsin sands. It will stand very hard ramming or pressures.

CENTERTON VIBRATORY TEST
Morgan County Bond, 20%; Silica, 64%
Silt, 15.55%

This specimen is very rough and contains a large amount of gravel. It would probably be useful in heavy pipe work or like castings, where finish is not important.

RIVER GROVE SAND (CORE) VIBRATORY TEST
Mishawaka County Bond, 22.50%; Silica, 77.50%

This sand is of the same texture and grain as the Custer Park sand. It makes a good core-sand but care must be taken with the binder used or cores will become too close.

It is not advisable to use this as a molding sand inasmuch as it weakens so easily on account of fineness of grain.

CUSTER PARK SAND VIBRATORY TEST
Porter County Bond, 14.28%; Silica, 85.71%

This is a fine, open grained sand, usually used as a core-sand, where a fine finish is desired in the interior of the castings. It can be used as a molding sand in castiron for very light castings, where unusually fine finish is desired, but on account of its excess fineness it would not be safe to use for anything heavy. This sand must be handled with care as it will weaken easily. It makes a splendid core-sand, but cores should be vented and binder not used too strong. It is usually used for stand-up cores.

LAKE CICOTTE VIBRATORY TEST
Cass County Bond, 7.40%; Silica, 92.50%

This is a wonderfully even grained fine sand, suitable for light cores made in driers or one-half cores on plate. The bond is not sufficient for standup cores and for the same reason it is not suitable for a molding sand, unless blended with a stronger grade of fine sand, where an opener is needed. It has a composite fineness of 70%.

VIBRATORY TEST
PATOKA NO. 1 Bond, 27.58%; Silica, 72.41%
Patoka, Gibson County

This is an even grained extremely open strong bond sand, suitable for radiator castings and all classes of work which require hard ramming or pressures, or deep pocket work. It is useful as an opener for the medium class of castings. This sand is of the same character as the Wanetah or Canadian sands.

VIBRATORY TEST
PATOKA NO. 2 Bond, 18.36%; Silica, 81.63%
Patoka, Gibson County

This sand is of the same general texture as the No. 1 Patoka, excepting that it has less bond and it is suitable for the same general class of work. It is an even grained, medium strong and open sand.

VIBRATORY TEST
PATOKA NO. 3 Bond, 17%; Silica, 82%
Patoka, Gibson County

This sand has the same characteristics as the Patoka No. 1 and No. 2 but it is much finer in grain. It is an open and strong sand.

VIBRATORY TEST

PATOKA NO. 5 Bond, 68.42%; Silica, 31.57%
Patoka, Gibson County

This is an extremely fine sand and while it is also a strong sand it is not advisable to use on any form of castiron work. It might possibly be useful as a binder for weakened brass sands, but extreme care is necessary in its use for other than skin-dried molds on account of its high percentage of bond and excessive fineness.

VIBRATORY TEST

PATOKA NO. 6 Bond, 23.66%; Silica, 73.33%
Patoka, Gibson County

This is an open, strong, medium heavy grained sand, useful for medium castings, bench, machine and floor molding. This sand has a very even texture and should provide a good finish to general castings. If excessive core work is used a good binder should be at hand.

VIBRATORY TEST

PATOKA NO. 7 Bond, 55%; Silica, 45%
Patoka, Gibson County

This is a medium grained sand, very strong and open. It should prove a long-wearing strong sand for general jobbing foundries, and agricultural work. Care should be taken not to overdo the use of new sand on account of its very strong bond. It is of very even texture and a high heat resistant, free from silt. The bond is dark yellow in color.

All of the Patoka sands are of a silica-rock formation and exceedingly open.

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The foregoing sands of Indiana are mainly from the Ohio River deposits, which range all along the Indiana, Ohio and Kentucky hills and valleys in varying grades of fineness. Some of these grades excel any in the Country for uniformity of texture and finish of castings.

Good molding sands of almost every known grade may be found in this State with excellent transportation facilities in every section.

Additional molding sands are also produced in Clark, Clay, Jackson, Park, Porter, St. Joseph and Wayne Counties.

Part 5, "Economic Geology of Indiana 1922" Chapter XIII gives a short synopsis of the foundry sands produced in the State, covering the essential properties, chemical composition, mechanical composition, distribution and geological occurrence, the latter being described in the following words, which are exceedingly interesting:

"Foundry sands generally belong to that class of materials, known as mantle rock. They may consist of residual materials or of transported materials. The transportation of the individual particles may be accomplished through the agency of ice, water or wind, or any two or all.

"The core-sand obtained from the Dune area of

Lake Michigan was first transported by ice and later by winds.

"The Molding sands of the glacial portion of the State are probably glacial in origin and partly residual. Practically all of the foundry sands in Indiana are of Pleistocene or Post-Pleistocene age."

The following interesting statement is also made:

"Production—in 1918 Indiana used 160,851 tons of Foundry sand, which cost $310,748. Only 55,116 tons of a value at $72,326 were produced in the State, while 105,375 tons valued at $238,152 were supplied from outside sources."

This apparently represents the condition of affairs in every large foundry section of the United States. The "fields afar are the greenest."

In Indiana may be found sands of every known grade and essential quality, still the Indiana foundryman ignores the cost at home $1.31 per ton average, and purchases his sand abroad at $2.25 per ton average. This represents a difference in cost of $238,152, which if saved would pay for a great deal of sand study and tempering devices and the resultant reduction of losses, which are beyond computation.

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IOWA

U. S. Bulletin 624, 1917 gives Molding Sands as dug at Centerville, Appanoose County, Kimbleton, Audubon County, Cherokee, Cherokee County, Cedar Rapids, Linn County, Doon, Lynn County, Marshalltown, Marshall County, Desplaines, Polk County and Valley Junction.

The Iowa Geological Survey Report of the State Geologist, December 31st, 1920, gives a production of two hundred thousand tons of sand for paving purposes and over one million tons of sand for building, but strange to say, nothing is said of Foundry Sands.

BLACKHAWK SAND VIBRATORY TEST
Blackhawk County Bond, 21.42%; Silica, 78.57%

This is a fine, even grained sand and is used very extensively in the Eastern Section of Iowa. It is suitable for brass and very light hardware.

VIBRATORY TEST
HEAVY MACHINERY SAND Bond, 27%; Silica, 73%
Ottumwa, Wapello County

This is a floor molding sand of excellent quality of heavy grain. It has a very even texture and a strong clay bond. This should prove an excellent sand for heavy green sand molding, boiler sections and machinery castings.

This sand is free from lime content and has a heavy quartz grain. It should wear well under hard usage. The evenness of texture insures an excellent finish for heavy castings.

VIBRATORY TEST
MEDIUM SAND Bond, 46%; Silica, 54%
Ottumwa, Wapello County

This is a good sand for general use and core work, also heavy bench molding and floor work.

It is of medium heavy grain and has a very even texture, being strong in bond and open. It should provide an excellent finish and stand hard usage.

On account of its exceedingly strong bond, care must be taken to avoid excessive additions to the heap.

	VIBRATORY TEST
CORE MOLDING SAND Ottumwa, Wapello County	Bond, 23%; Silica, 77%

This sand is suitable for general jobbing work and machinery castings. The shipper of this sand recommends it as a core molding sand, but unless it is used in connection with a straight silica sand, it would be very apt to cause trouble with blowed work on account of its strong bond and a percentage of silt present, which might close up between the grain and prevent the escape of gases.

Properly handled, this sand is of about the same general character as Wanetah, Niagara and Ontario Sands, but has a high bond content.

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KANSAS

No molding sands reported.

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KENTUCKY

This state produces some of the most valuable molding sands in America. The principal sources of supply are along the Ohio River and its branches from Ashland, Ky., in the Eastern section, along the

Big Sandy River, bordering the Virginia line. Lawrence, Boyd, Greenup Counties on the East; Lewis, Mason, Campbell and Boone Counties on the North are the most convenient for shipping to the foundries of the Ohio Valley.

Newport, Kentucky, is probably the greatest shipping point on account of its closeness to the foundry centers and railroad facilities.

Kentucky has devoted its greatest endeavor through its geological survey to the study of glass sands, Series Six by Charles Henry Richardson, 1920, giving a very thorough and complete study of this class.

The very fact that this high silica sand is plentiful in all sections, should insure great values in the molding sand deposits of this State, when a greater demand requires its development.

PARIS T-5	VIBRATORY TEST
Bourbon County	Bond, 50.81%; Silica, 48.14%

This is one of the most remarkable sands in the collection. It is an extremely fine sand of even texture being equal in grain to an imported French sand. If it were not for the slightly higher bond content in the Kentucky sand, it would be impossible to distinguish the one from the other. The sand is fine enough for jewelry and plate and should prove suitable for aluminum ware on account of its openness, which is a characteristic of sands from glass-sand producing districts.

The color of this sand is light yellow, the same as the French sand with an extremely light ring of igneous rock showing at the parting between the bond and silica as separated by water, but this is not sufficient to affect the sand.

VIBRATORY TEST
ASHLAND—STEEL SAND Bond, 26.0%; Silica, 66.0%
Lawton, Carter County Silt, 8.0%

This is a medium fine grain open sand of very even texture, used in making ingot molds and general castings up to 10,000 pounds. It is an excellent heat resistant and should give excellent service if blended with a heavier grained, stronger bond sand of the same character, which may be easily procured in the Ohio district.

The small percentage of silt shown is not harmful and might be classed as silica.

MENTOR NO. 1 VIBRATORY TEST
Mentor, Campbell County, Ky.
See No. 3 Mentor

This is a fine sand, very even in texture and having an exceedingly high bond. It should prove a good strengthener for weakened heaps, but great care must be taken against using too great quantities at one time.

It is an excellent sand for light hardware, bench molding and brass, or wherever finish or plating is required. It should be blended with a more open sand of same grain size for best results.

VIBRATORY TEST

NO. 3 MENTOR Bond, 55.0%; Silica, 45.0%

Mentor, Campbell County, Ky.

This is an extremely strong fine sand, with bond out of proportion to the silica. It is a splendid sand for strengthening weakened heaps but should not be used alone A sand lower in bond must be blended with it. This would be an excellent control sand for the finer grades, but it should be used sparingly.

VIBRATORY TEST

NEWPORT NO. 00 Bond, 23.8%; Silica, 76.19%

COLOR: DARK BROWN

This is an excellent fine grain open sand and is identical in character with Dyeton and many other sands on both sides of the Ohio River, in the hills adjoining. It can be had in varying degrees of fineness, openness and bonds and will cover a wide range of fine casting production.

This sand is mostly mined in the hills, with usually a very light over-burden. Sometimes, just turning over the sod will show finer grades close to the surface. The evenness in texture insures excellent finish to brass castings and in the more open grades it is widely used for light hardware and work to be plated.

The veins usually vary from three to eight feet in depth, increasing in coarseness at the bottom. Below is usually a good grade of building sand and gravel.

NEWPORT—DYE SPECIAL

COLOR: DARK YELLOW VIBRATORY TEST
Bond, 47.36%; Silica, 52.63%

This is simply another grade of fine, molding sand, the same as the Dyeton or Newport 00. The only difference is in the fineness of grain. It is suitable for all classes of very light work to be japanned or plated.

This sand is noted for its uniformity for the last thirty years.

ASHLAND A-1

VIBRATORY TEST
Bond, 17.24%; Silica, 82.75%

This is another wonderful grade of extremely fine sand, having a most uniform grain. It is very open but has a very good heavy bond and when tempered it fairly sparkles with quartz crystals. The openness of this sand should insure safety for very hard ramming for aluminum work and its texture should insure fineness of detail. It should show well with French sands, Windsor Lock or the finest of Albany sands, in art castings. It has a fineness of 95.24% according to the sieve test.

Bulletin No. 624, U. S. Geological Survey shows molding sands mined in Boyd, Campbell, Jefferson, McCracken and Warren Counties.

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LOUISIANA

No molding sand produced in this State.

MAINE

No molding sands have been reported as being produced in Maine.

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MARYLAND

The United States Geological Survey Bulletin 624, 1917, gives molding sands in Anne Arundel County, Magothy River, Washington County at Rock Forge.

The Maryland Geological Survey have not yet completed a report but have men in the field investigating.

Extensive investigations were made during 1925 in Prince George and Calvert Counties and there is every indication of high grade molding sand deposits.

The following specimens submitted show that all that is necessary is a thorough development of one of the most promising fields in the State.

MEDIUMMILL GRAVEL — VIBRATORY TEST
Calvert County — Bond, 60%; Silica, 40%

This is a heavy coarse-grained sand with a strong bond of a molasses-like nature. It is almost a duplicate of the well known Millville gravels of New Jersey and Vandalia Red sands of lower Illinois or the Hamilton County Red sands of Ohio.

It is a very useful sand in steel or heavy machinery molding or castiron pipe foundries.

Caution should be used in distributing the new sands thoroughly in the heaps.

COARSE MILL GRAVEL

Calvert County

This is of the same general character as the Medium sand from this same location but as its name implies it is filled with numerous particles of gravel one-eighth to one-quarter of an inch in diameter. Tests show no lime content. It is heavy in grain and strong in bond.

VIBRATORY TEST

*NO. 0 MARLBORO

Bond, 25%; Silica, 75%

Marlboro, Georges County

This is an exceedingly fine sand of very even texture. It is suitable for non-ferrous metals only, but is too close in grain for safety in light castiron hardware.

VIBRATORY TEST

*NO. 1 MARLBORO

Bond, 7.1%; Silica, 92.9%

Marlboro, Georges County

This is a very fine grained sand, of even texture. It has a very low bond content and is of very low strength. This sand is only useful for non-ferrous metals and would prove of very short life. It would make an excellent core-sand for light standup cores.

It is similar to the Custer Park sands of the Indiana Dunes.

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*It is possible that the shipper may have crossed the markings of No. 1 Marlboro and No. 0 Marlboro.

NO. 3 MOLDING SAND

Calvert County

This is a medium grained sand of very even texture, suitable for almost every grade of bench or machine molding and light floor molding. It has a strong bond and should provide an excellent finish for general castings. It will wear well.

The specimen submitted was too small to allow for a Vibratory Test, but it is of the same general character as fifteen other specimens sent, three or four of which will be tested in varying grades.

NO. 2½ RED STRONG

Calvert County

VIBRATORY TEST

Bond, 15.0%; Silica, 85.0%

This is a beautiful even-grained strong sand, suitable for all classes of light hardware. It should give an excellent finish and wear well. It is a beautiful sand for bench or squeezer work.

NO. 2½ MEDIUM

Calvert County

This sand is of the same general character as the No. 2½ Strong, only slightly finer. It is very even-grained.

NO. 2½ DARK RED

Calvert County

This sand is also of the same general character as the No. 2½ Strong and No. 2½ Medium only that it is slightly heavier in grain and Dark Red in color. It is of very even texture.

No. 2½ WILSON'S — **VIBRATORY TEST**
Wilson, Calvert County — Bond, 35%; Silica, 65%

This is one of the most excellent sands of the State. It is very even in texture, having a high bond, which is so much to be desired in the Eastern sands.

It is an excellent sand for light castiron hardware, which would require plating or enamel. It will furnish an excellent binder for any of the low bond, fine sands of the East. It is a very suitable sand for brass or any of the non-ferrous metals.

It is an ideal example of colloidal bond, while settling in the Vibratory Test, having the appearance of heavy thick cream. Owing to the high bond content a word of caution is necessary to not use in excessive quantities. Only use from day to day that which is necessary to replace the bond which has been destroyed.

No. 2 EXTRA STRONG — **VIBRATORY TEST**
Calvert County — Bond, 54.2%; Silica, 45.8%

This is a medium grained sand and as its name implies, it has a very strong bond and would be useful for strengthening up weakened heaps.

This sand should always be used in connection with a more open sand. It should prove a very desirable sand where the heaps have been weakened by silica sand cores or by hard usage.

No. 2-2½ Medium
Calvert County

This sand is of the same general character as the other Calvert County sands, being just about as strong in bond and very even texture.

No. 2-2½ Strong — Vibratory Test
Calvert County — Bond, 45%; Silica, 55%

This is a medium fine grained sand of very even texture, with an extremely high bond. It could not be used alone in its present shape. It should prove an excellent binder for weakened heaps. It is doubtful if there is its equal outside of the Ohio and Kentucky fine sands for bond renewal. It would blend perfectly with any of the low bond, fine sands.

Care must be taken not to use too large quantities at one time.

No. 2 Medium Bond — Vibratory Test
Calvert County — Bond, 36%; Silica, 64%

This is another beautiful grade of sand, similar in texture and grain to the Newport sands of Kentucky. It is very useful for light hardware, particularly where a very fine finish is desired. Care must always be taken to avoid excessive additions to the heap. This should prove a very useful sand for blending with weaker grades.

No. 1½-2
Calvert County

This sand is of the same general character as the other Calvert County sands, being very fine in grain and having a good bond.

No. 1½ VIBRATORY TEST
Calvert County Bond, 36%; Silica, 64%

This sand is very fine in grain. It is of even texture and has a heavy bond. It should prove suitable for brass, non-ferrous metals and some of the lighter grades of castiron hardware which require plating or enamel.

Care should be taken not to renew heaps too frequently or use excessive amounts at one time.

This sand is a splendid strengthener for weak fine sands.

No. 1-1½ YELLOW
Calvert County

This is a beautiful fine grained strong bond sand. It is almost an exact duplicate of the finer grades of Kentucky sands and should prove a splendid strengthener for fine weak sands. It should give an excellent finish to the castings.

No. 1 STRONG VIBRATORY TEST
Calvert County Bond, 12%; Silica, 88%

This is a fine sand of very even texture. It is classed as a strong bond sand, but the Vibratory Test shows the bonding value not up to the same standard as other grades from this district. It is much darker in shade and the bond settles much more quickly and is weaker. This specimen was probably taken from a wind-blown deposit. It is good sand for blending purposes.

No. 0 STRONG — VIBRATORY TEST
Calvert County — Bond, 25%; Silica, 75%

This is an extremely fine sand with a very strong bond. It averages fineness of 83.4% and 23% passed through a 150 mesh sieve. Great care must be taken wherever this sand is used on account of the high bond for so fine a sand. It would work better blended with a slightly heavier grained sand of lower bond content.

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MASSACHUSETTS

U. S. Bulletin 624, 1917, gives molding sands mined at Cheshire, Berkshire County, East Bridgewater, Plymouth County; Worcester, Worcester County. No specimens of molding sand from this district have been obtained.

SAND BLAST SAND

Provinceton, Branstable County, Mass.

A very heavy quartz rock, grain of uniform texture, for sand blast purposes. This should also be useful in steel molding.

Provinceton is located at almost the tip end of Cape Cod and is ideally situated for water transportation.

CORE SAND

Wareham, Plymouth County, Mass.

This sand has a striking similarity to the Dune sands of the Lake Regions. It carries a slight bond content and is only suitable for core purposes.

A Missouri Glass Sand Deposit

FINE CORE SAND OR
FURNACE BOTTOM SAND
Wareham, Plymouth County, Mass.

This sand is similar to other Wareham core sands, but of finer and more even grain.

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MICHIGAN

U. S. Geological Bulletin No. 624, 1917, states as follows:

"Molding sands occur generally in small deposits or pockets at many places in the State. These sands are utilized by local foundries and occur in the following counties—Berrien, Calhoun, Eaton, Ingham, Macomb, Tuscola, Manistee and Oakland.

VIBRATORY TEST
ST. JAMES SAND Bond, 55.55%; Silica, 44.45%
Riverside, Berrien County

This is a beautiful grade of fine sand of very even texture. It is useful for all classes of bench or light castiron floor work. Great care must be taken in its use to avoid excess additions to the heap on account of its high bond.

ALLEGAN NO. 0—Upper Layer VIBRATORY TEST
Allegan, Allegan County Bond, 35%; Silica, 65%

This is an excellent fine sand, suitable for brass, non-ferrous metals and very light hardware. Fineness of grain assures excellent finish for castings, which require plating. Care must be taken in gating to allow sufficient area in runners to avoid force of entry of the metal into the mold. The bond is excellent in proportion to the grain.

NO. 0 ALLEGAN—Lower Layer VIBRATORY TEST
Allegan, Allegan County Bond, 47%; Silica, 53%

This sand is of the same general character as the No. 0 Allegan, Upper layer, being slightly finer in grain and somewhat heavier in bond. If blended with the upper layer, it would give better results.

This specimen when blended with the upper layer of Allegan No. 0 shows a bond of 40% and silica 60% (Vibratory Test). When both the upper layer and lower layer are blended with an addition of 20% of sharp sand the Vibratory Test shows the following results: Bond, 33%; Silica, 67%.

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MISSISSIPPI

No specimens received. U. S. Geological Survey Bulletin 624, 1917, gives molding sands dug at Corinth, Alcom County and Jackson, Hinds County.

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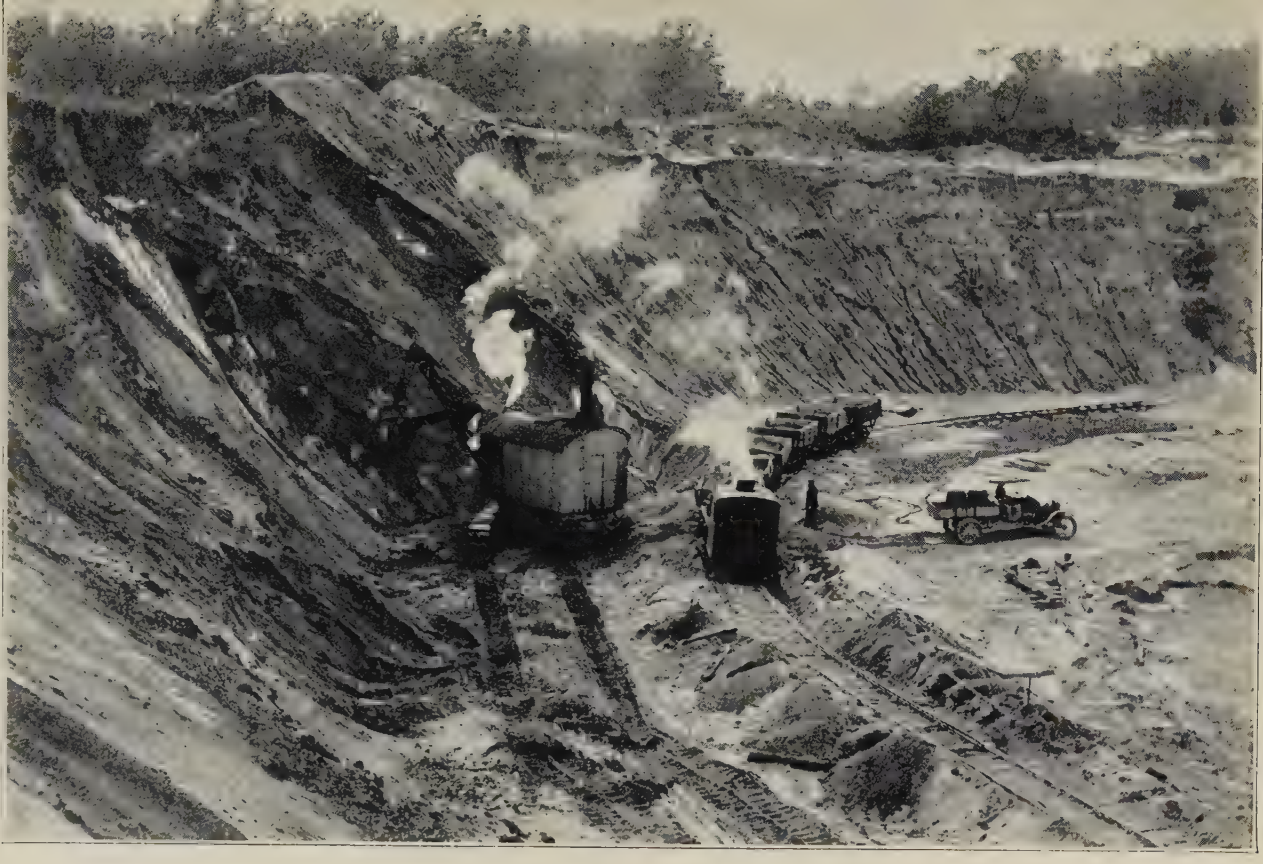
MISSOURI

U. S. Geological Survey Bulletin No. 624, 1917, gives molding sands as dug at the following points:

A number of small pits in Franklin County at Gray Summit and Pacific—Black Hills, Kenty County and Klondike, St. Charles County.



New Jersey Deposit—Showing Activities

NEW JERSEY

The sands of New Jersey are very well known in the foundry world, particularly the heavier grades used for steel and heavy castiron work, coming from the Lumberton district, along the Rancocas Creek to the Delaware River, also the Millville district farther South.

The Annual Report of the State Geologist, 1904 (Henry B. Kummel), assisted by S. H. Hamilton, in Part IV. entitled *"A Report of Some of the Molding Sands of New Jersey"* gives a very thorough description of these sands and their characteristics and the writer will not attempt to repeat the good work already covered.

The New Jersey Lumberton and Millville sands of different grades bear the same relations to the manufacture of steel and heavy work that the Albany and Kentucky sands do to light work.

The origin of these sands no doubt lies in the mountains to the north, carried by the waters of the Delaware to the lower lands and deposited all along the river lowlands, there to remain until called for by man.

Naturally these sands are dug at most available points to the markets, and in this case, the Delaware River is convenient to all for shipment to Philadelphia, Pa., and Camden, N. J., and railroad transportation is available to all points.

A few specimens as submitted to the writer's collection follow, with opinions as to their application and usefulness. These specimens do not by any means cover all sands produced in New Jersey and the opinions given are only as they appear to the writer from a foundryman's point of view.

MILLVILLE SPECIAL NO. 4 VIBRATORY TEST
Cumberland County Bond, 48.38%; Silica, 51.51%

This is a coarse strong open sand, suitable for heavy castiron and steel castings. This particular sand is one of remarkable characteristics. When dry, it is not a very attractive sand, but when rubbed out and moistened it becomes dark red in color with an exceedingly strong molasses-like bond.

Like most other sands from the Millville district, it immediately impresses you as a high test resistant.

Its heavy grain denotes the character of the work to which it is best suited, i. e., heavy castings or steel molding.

This sand is dark yellow in test or dry, showing a high alumina content. When tempered thoroughly it assumes a smooth, velvety feeling, contrary to that which is expected before tempering. There is a remarkable resemblance between this sand and that produced at New Lexington, Ohio.

VIBRATORY TEST
MILLVILLE NO. 1 Bond, 25%; Silica, 75%
Coarse Foundry Gravel

As denoted this is a very coarse gravel-like sand, with a 25% bond, giving it a great value in combination with other sands in heavy loam molding.

There is a peculiar feature to this sand—when the

Vibratory Test is made the bond portion shows two distinct separations about 50-50—the alumina above, as indicated by its yellow color, and the iron-oxide below, as indicated by the red color. The silica division is shaded yellow with a sprinkling of black or igneous rock particles. Sands of this character give the best service when tempered or mixed in pan mills.

MILLVILLE NO. 2 VIBRATORY TEST
Coarse Grit Bond, 20.68%; Silica, 79.31%

This is a heavier form of foundry gravel, suitable for use in steel molding combinations. It has a very heavy coarse silica grain and very even in structure. It should be a very high heat resistant. There is a very well defined sprinkling of black rock grains.

MILLVILLE NO. 3 FINE—STRONG STEEL SAND
VIBRATORY TEST
Bond, 39.28%; Silica, 60.71%

This is a fine grained sand of beautiful even texture. It is very strong and its fineness of grain should insure smooth finish when combined with heavier sands. Like all other sands from this district it creates the impression of being a high heat resistant and should wear well.

Color: Yellow Alumina Oxide, with a slight dark red ring of iron oxide in the test.

MILLVILLE VIBRATORY TEST
Coarse Jersey Fire Sand Bond, 8%; Silica, 92%

This sand is used for heavy castiron and steel combination as the name signifies. It is a high heat resisting sand, very open and with a coarse grain. It is used as an opener or for dry sand core combinations and may also be used in connection with cupola furnace and ladle daubings. It is light yellow in color with a sprinkling of dark grains.

LUMBERTON
Burlington County

Lumberton sand, like the Albany sands, has acquired a reputation in the foundry world and particularly East of the Ohio Valley, but not for the same class of work. This sand has its greatest value in the production of heavy and medium heavy castiron bench and floor work, the various grades covering castings varying from 10 pounds to 10,000 pounds. The greatest value of this sand has been in the results given with green sand molding on such castings as large lathe beds, tanks, large valves, fittings, heavy machinery castings, etc. There is a pronounced sprinkling of black rock grains in this sand, and although heavier, it is identical in appearance with North River sands of the Albany district. Tabulated below are three grades:

	Silica %	*Bond* %	*Grade*	*Color*
Mild	82.60	17.39	Med. Fine	Yellow
Medium ...	85.95	13.04	Med. Coarse	Dk. Yellow
Strong	76.00	24.00	Coarse	Dk. Yellow

NEW YORK

The geographic distribution and various characteristics of Albany Molding Sands of the Hudson Valley have been pretty thoroughly covered recently in a pamphlet distributed by the New York State Museum, compiled by Charles M. Nevin, (No. 263, June, 1925).

In the early days, previous to the era of railroad transportation, when bells, kettles, anchors, grates, mantles, iron pots and andirons, dutch-ovens, woodburners, ets., were the principal foundry products, the foundries depended mainly on water transportation for their sands. The Hudson River then and still is the main source of this product and means of transport. As the industry moved West, like all others, it became difficult for most foundrymen to adjust themselves to the Western sands as they were invariably higher in bond content and created losses. The natural result was to return to the original sands which acted as an opener and gave the desired results.

The continuous and excessive use of low bond sands would naturally create losses also and there became a generally unsettled condition between the producers and the consumers and a constant change of grades, kinds and quality of sands used, through no fault of either.

In certain lines of work the Albany sands acquired a world-wide reputation. In connection with this it would be well to study carefully the "Characteristics of Molding Sand Deposits" on Page 10 of Bulletin

No. 263 as shown in the first paragraph. This paragraph might well apply to any one of the sand territories of the United States and should lead the foundrymen of the Country to understand that no particular deposit may be taken as a cure-all and applied to every grade of castings. When he once becomes familiar with his actual requirements and purchases his sand to suit his own particular needs, and not because some other foundryman may have used it, there will be a far better understanding between the producer and the purchaser.

The bulletin of the New York State Museum No. 263, gives the following deposits in seven counties, parallelling the course of the Hudson River:

Gansevoort
Saratoga Springs
Schuylerville
Burgoyne Crossing
Wayville
Hines Switch
Ballston Spa
Wilburs Basin
Mechanicville
Reynolds
Ushers
Round Lake
Schaghticoke
Elnora
Alplaus
Carmen
Schenectady
Staatsburg
New Hamburg
Marlboro
Waterford
Van Hoosen
Vischer Ferry
Karness
Crescent
Niskayuna
West Albany
Elsmere
Delmar
Slingerlands
Glenmont
Wemple
Selkirk
Coxsackie
Stuyvesant
Port Ewen
South Roundout
Poolsburg
Camelot

A New York Sand Pit

U. S. Geological Survey Bulletin No. 624 gives in addition, the following deposits:

Cohoes	Albany County
Auburn	Cayuga County
Dunkirk	
Fishkill Landing	Chautauqua County
North Collins	Erie County
Booneville	Oneida County
Fish Creek	Oneida County
Forestport	Oneida County
Rome	Oneida County
Fulton	Oswego County
Rensselaer	Rensselaer County
Jonesville	Saratoga County

Tabulated herewith will be found fourteen samples of sand submitted, eight of which are from the Albany District and six from the North River pits. The various grades would cover almost every requirement of castiron bench work, light floor work, stove-plate, etc., with but slight variation in finish of the castings:

Albany Sands—Vibratory Test

No.	Grade	Silica	Bond	
00	Fine	75.00%	25.0 %	Open Strong
1-0	Fine	93.75%	6.25%	Very Open
1½-0	Fine	94.44%	5.55%	Very Open
2-0	Med. Fine	75.25%	24.74%	Open Strong
2½-0	Coarse	87.5 %	12.5 %	Very Open—Strong
1-M	Fine	84.37%	15.62%	Very Open—Strong
1½-M	Fine	78.94%	21.05%	Very Open—Strong
2-M	Med. Fine	68.28%	31.70%	Med.—Very Strong

North River Sands—Vibratory Test

3	Coarse	76.92%	23.07%	Open Strong
4	Coarse	80.00%	20.00%	Very Strong
000	Very Fine	90.00%	10.00%	Very Open—Strong
00	Fine	92.10%	7.89%	Very Open—Strong
0	Med. Fine	85.70%	14.28%	Open Strong
	AVERAGE	83%	16.74%	Open, Med. Strong

* * * * *

The general average silica, 83% (Vibratory Test), indicates very open sands and the average bond 16.74% (Vibratory Test), would insure safety in molding.

These sands are all suitable for heavy ramming and pressures, but to insure the life of the heap, a strong bond sand should always be kept at hand for renewal, such as shown in the 2-M sample or stronger.

The general supply of New York sands would appear almost inexhaustible.

These sands are *Dark Yellow* in color with very pronounced shading of black grains in the silica.

Albany Sand

Sample of No. 2 and No. 4 "used" sands were tested for opinion and herewith is the answer as given:

No. 2 Bond 32.35%—Silica 67.64% } Vibratory
No. 4 Bond 35.48%—Silica 64.51% } Test

This sand appears in excellent condition having an unusually strong bond for Albany sands.

The sand as submitted is too fine in grain for the class of castings being made. A heavier grained sand would improve the product and save losses. The writer would suggest that the bond should be kept at

30% and silica 70% though a variation of 4% either way in the daily tests will not harm. The sample submitted did not permit of a sieve test.

Albany Sand Vibratory Test
Bond, 12.82%; Silica, 87.17%

Sample of new sand submitted, which was being used regularly. This is a very even quartz grained sand and should prove a very fine sand for brass. It should also prove an excellent sand for finish, having a very low percentage of excess fineness and should insure freedom from cut sand and leakage when castings are tested.

This sample passed through 20 mesh sieve, 98% and through 100 mesh sieve, 3%.

West Albany No. 00 Vibratory Test
Albany County Bond, 25%; Silica, 75%

This is a medium sand of even grain and should prove a good sand for brass and non-ferrous metals and very light castiron. It should wear well and provide a good finish to the castings. It is very even in texture and no silt shows in test.

West Albany No. 0 Vibratory Test
Albany County Bond, 30.43%; Silica, 69.56%

This is an exceedingly fine grained sand, for brass and non-ferrous metals. It is also suitable for extra light castiron work.

West Albany No. 1 Vibratory Test
Albany County Bond, 30%; Silica, 70%

This is a medium heavy grained sand, having no silt. It is suitable for non-ferrous metals and light castiron work and should also give good results on medium heavy brass castings.

West Albany No. 2 Vibratory Test
Albany County Bond, 32%; Silica, 68%

This is a heavy grain open strong bond sand, suitable for light castiron, bench and squeeze work. It should provide clean castings and good finish and should wear well.

West Albany No. 3 Vibratory Test
Albany County Bond, 20.83%; Silica, 68.75%
Silt, 10.41%

This is a very heavy grained sand, very open and medium strong bond. It is only suitable for castiron general castings, squeezer bench and light floor molding. It is slightly uneven in texture, on account of a slight silt content. Care should be exercised in using where castings require air tests.

No. 0 Albany Vibratory Test
Schenectady, N. Y. Bond, 34.14%; Silica, 65.85%

This is a strong bond, open, medium fine sand, suitable for all classes of medium bench work, stove plate, hardware castings, etc. It is an excellent even grained sand and on account of the fairly heavy bond it should give good wear.

Albany No. 1 Vibratory Test
Schenectady, N. Y. Bond, 21.05%; Silica, 78.94%

This is a very open, fine grain sand, suitable for light bench work, stove plate brass, etc. If used with excess core droppings, this sand would weaken easily, hence extra sand would be needed as a binder.

VIBRATORY TEST

NORTH RIVER NO. 1 Bond, 42%; Silica, 58%

(Special Sample Submitted)

This is a medium heavy grained sand, useful for bench and light floor work. It should wear well, but care must be taken in adding excessive quantities of new sand on account of the heavy bond. This is a very useful sand when large quantities of core-sand are returned to the heap. When cores are not used this sand has about 15% more bond than is necessary and is far above the average in bond of New York sands. It should be an excellent sand for renewing heaps weakened by hard usage or excess sea-coals.

* * * * *

NOTE: Only a few of the New York sands are given, inasmuch as the general character of the sand is about the same and is generally known.

The New York State Museum Bulletin No. 263, on Page 10, edited in June 1925, in referring to the characteristics of the molding sand deposits to be found in the State, tells us that an outstanding characteristic of the Albany molding sands is that within a short distance they show great variations in practically all their physical features. Indeed, there appears to be no uniformity in distribution, topographic form, thickness or physical properties, and since these variations control every phase of the molding sand industry, as well as the probable origin of the deposits, a correct appreciation of them is essential.

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OHIO

The Ohio Valley in the 70's, was considered the coming foundry center. Coal, Coke, Iron, Sand and every other necessary commodity were easily obtained. Of all the States in the Union, Ohio should have the least trouble of any in procuring foundry sands for every known class of castings.

North in the Lake Regions, South in the Valleys of the Ohio, East in the Mining Districts and West in the hills adjoining the Whitewater Valley of Indiana, The Big Miami, The Little Miami, the Muskingum River, the Lake Region, and the Ohio River, together with the deposits of the glacial periods, give every possible source and condition productive of good molding sands.

The writer believes any sand on earth can be duplicated in this State. This should hold the professional pessimist who is always crying the possibility of sand shortage.

A very complete paper, by the State Geologist of Ohio (J. A. Bownocker), entitled *"Iron Molding Sands of Ohio,"* February, 1923, covers this subject more fully than could possibly be done by the writer.

NO. 2 GREENVILLE SAND   VIBRATORY TEST
Drake County   Bond, 32.65%; Silica, 67.34%

This sand is dug in the West Central part of the State on a branch of the Stillwater River. It has a

An Ohio Sand Deposit

heavy quartz grain and a strong bond suitable for heavy castings, castiron and steel. The test sample shows three divisions—a strong band of reddish brown silt showing, but not enough to be harmful.

ZANESVILLE—IRON KING NO. 1 VIBRATORY TEST
Muskingum County Bond, 50%; Silica, 50%

This is a beautiful specimen of molding sand of very even texture and entirely free of silt. The bond is exceedingly high and makes it a most desirable sand for strengthening heaps, where they have been weakened by excess cores, excess sea-coal or hard usage. It will stand hard usage and is suitable for all grades of railroad castings, draw bars, etc., also general machinery castings, floor or bench work. Care must be exercised to avoid excessive additions to the heap.

IRON KING NO. 2 VIBRATORY TEST
Bond, 32.0%; Silica, 68.0%

This is a beautiful sand of medium grain and very even texture. It is suitable for all classes of medium heavy castings weighing from 10 to 500 pounds. It has a strong bond and should wear well. It is free from silt and should provide a good finish. It should prove an excellent sand for fittings or valve work and a good sand for heaps, which have become weakened by core-sand.

VIBRATORY TEST
INDIAN RED NO. 5-20 Bond, 50.0%; Silica, 50.0%
New Lexington, Perry County

This is a heavy grained sand of even texture.

There is no silt present. It is suitable for all grades of heavy bench work and floor molding. It has an excellent grain for opener for facing sands and should wear well. Care must be taken in adding to heaps and it is necessary to avoid excess on account of the heavy bond.

Vibratory Test

Indian Red No. 5-10 Bond, 29.03%; Silica, 70.96%
New Lexington, Perry County

This sand is heavy in grain of even texture and low bond. It is an excellent foil for the No. 5-20 sand in bond control and should wear well. This sand may be used alone on light castings where the finish is not affected by the grain size. It is very refractory and open and will stand hard usage but bond must be replaced as burned out.

Vibratory Test

Indian Red No. 5-30 Bond, 35.0%; Silica, 65.0%
New Lexington, Perry County

This is an open sand of heavy grain and even texture. It is suitable for heavy machinery, bench molding and floor work and should stand hard usage and wear well.

Vibratory Test

Indian Red No. 4-30 Bond, 36.0%; Silica, 64.0%
New Lexington, Perry County

This is a fine-grained open sand, suitable for light work only. It should give good finish and wear well.

Vibratory Test

No. 5 Rogers Bond, 33.33%; Silica, 66.66%
New Lexington, Perry County

This is a strong, open, even-grained sand, strongly quartz grained. It is suitable for heavy work and should provide good finish and wear well. If used for light work a more open sand should be added on account of the strong bond.

HAMILTON COUNTY VIBRATORY TEST
Heavy Machinery Sand Bond, 57%; Silica, 43%

This is an exceptionally heavy grained sand, with a strong bond. It should prove a suitable sand for heavy castings up to 100 tons, skin-dried molds, dry-sand molds or loam. There are not many localities producing this grade of sand, the States of Illinois, Ohio, Pennsylvania and New Jersey producing the greater part.

MA NO. 2 HEAVY MEDIUM
Hamilton County, Ohio VIBRATORY TEST
Bond, 22.22%; Silica, 77.77%

This is a medium fine grain sand, of even texture. It is an open sand suitable for all grades of light bench and squeezer molding. Should wear well and give good finish to the castings. It is dark brown in color and has no silt.

HAMILTON, OHIO VIBRATORY TEST
Reviver Clay Bond Bond, 66.7%; Silica, 33.3%

This is a very strong bonded sand and is excellent for strengthening weakened heaps. This sand should not be used alone on account of its high bond and must not be added to the heaps in excessive quantities.

HAMILTON "DRY MOLDING" SAND
Hamilton, Ohio

A good heavy grain, medium strong, open sand for heavy machinery and dry sand molding.

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PENNSYLVANIA

Pennsylvania, if sand was the only requirement for foundry practice, is probably the best provided for of any State in the Union. It has the Albany sands of New York on the North, the famous fire sands of New Jersey on the East, Maryland, West Virginia and Kentucky fine sands on the South and Ohio strong sands on the Western border, all convenient to the various foundry centers.

Outside of the above mentioned sands, there are forty known deposits of every grade needed within the State. The Western part might be classed as the Allegheny, Monongahela and Ohio River districts, the Center, the Juniata and Susquehana River districts and the Eastern deposits, the Delaware River districts, the deposits of the latter almost paralleling the New Jersey deposits along the Delaware.

U. S. Bulletin 624, 1917, gives molding sands as dug in the following counties: Allegheny, Beaver, Berks, Blair, Bucks, Butler, Carbon, Fayette, Franklin, Huntingdon, Lancaster, Lawrence, Lehigh, Lycoming, Mercer, Mifflin, Montgomery, Northampton, Northumberland, Philadelphia, Perry, Somerset, Sullivan, Venango, Westmoreland, and York.

Danville A.D. Vibratory Test
Montour County, Pa. Bond, 38.0%; Silica, 62.0%

This is a medium fine grain sand of very even texture and strong bond. It is useful for all grades of light castiron hardware and castings which require a fine finish. Will wear well. It is an excellent sand for brass and non-ferrous metals. It will stand hard ramming and pressures.

Danville B. S. Fine Vibratory Test
Montour County, Pa. Bond, 50.0%; Silica, 50.0%

This is of the same general character as the A. D. Danville, having about the same grain size with extremely heavy bond content. It is a splendid strengthener for weakened heaps but care must be taken against adding in large quantities to the heaps.

Danville B. C. Medium Vibratory Test
Montour County, Pa. Bond, 47.0%; Silica, 53.0%

This is of the same general character and grain size as the A. D. Danville and the B. S. Danville (fine) having a medium strong bond content between the former two grades.

These three Danville sands are excellent sands for blending purposes and shop sand control. Note: The varying grades of fineness are not due to varying grain sizes, but are caused by varying the bond content.

Revivo Vibratory Test
Bond, 52%; Silica, 48%

This is a prepared clay, ground from rock of a very refractory nature and entirely free from lime. It is an excellent binder for sands which have become weakened by excess core-sands or burning out.

It would seem advisable to use this material as a strengthener of weakened sands, but not as a substitute for sands which are known to be suited to the class of work to be made.

Excessive use of this material would only result in the same high losses which occur in the use of high bond sands in the West. Careful and intelligent application of this material in connection with low bond Eastern sands can only result in scrap reduction.

VIBRATORY TEST
R-50 Bond, 52.17%; Silica, 47.82%
Ridgeway, Elk County

This is a medium grained sand, suited to all classes of medium bench and light floor work. It should not be added to heaps in excess. It is of very even texture, and open, and will stand hard ramming and pressures. It should wear well.

VIBRATORY TEST
R-20 Bond, 23.80%; Silica, 76.19%
Ridgeway, Elk County

This sand is similar in grain to the R-50. It is of very even texture but lower in bond. The R-50 and R-20 sands should work well together for bond control. This sand alone would weaken quickly under hard usage but could be brought back quickly by use of the R-50.

NO. 1 GRANT—STRONG SAND VIBRATORY TEST

Bond, 43.75%; Silica, 56.25%

This is a very strong, even grained medium fine sand. It has no silt and should be a splendid strengthener for weakened heaps. The bond is too strong for the grain size.

It is useful for all grades of castiron and malleable medium heavy castings. A low bond sand should be used for control purposes and great care must be taken in adding new sand or in over-wetting. It will give excellent finish and wear well.

NO. 1 GRANT— MEDIUM STRONG VIBRATORY TEST

Bond, 33.33%; Silica, 66.66%

This is a splendid grade of sand, medium fine grain and a strong bond. Useful for all grades of castiron, malleable and miscellaneous castings. Care must be taken against excess amounts of new sand used at any one time. It will wear well and provide good finish.

NO. 1 GRANT—OPEN VIBRATORY TEST

Bond, 17.85%; Silica, 82.14%

As its name implies, this is a very low bonded sand, useful for blending with both the medium and the strong Grant sands for control purposes. It is a good sand for aluminum work but for castiron it must be strengthened. The noticeable feature of the three grades of Grant sand is the evenness of grain texture in each.

VIBRATORY TEST

NEWCASTLE NO. 0 Bond, 25.00%; Silica, 75.00%

Newcastle County, Pa.

This is a splendid grade of fine sand of unusually even texture. It is suitable for any class of light hardware and brass, where a good finish is required for plating, enameling or polishing. It is open grained and has an excellent bond. It may be used for radiator, stove, metal stair brass, or wherever finish is required. It should also be useful for art work and should wear well.

MERCER NO. 2 VIBRATORY TEST

Mercer County, Pa. Bond, 44.11%; Silica, 55.88%

This is a medium fine grained sand with strong bond. It is suitable for all grades of medium light castings, bench molding or press and general jobbing work. It is of wonderfully even texture and has no silt. It should wear well and provide an excellent finish. Should prove an excellent sand for enamelware castings. Care must be taken to avoid excess bond in heaps. This sand would prove an excellent strengthener for weakened heaps.

Pennsylvania Glass Sands

MAPLETON NO. 3—DAMP

Mapleton County, Pa. VIBRATORY TEST

Bond, 7.69%; Silica, 92.30%

This is a medium grain, white sand of even texture. Very little fines or discoloration and there is no outward indication of iron. It is useful in foundries for sand blast purposes.

HATFIELD NO. 3—DAMP **VIBRATORY TEST**
Hatfield County, Pa. Bond, 5.88%; Silica, 94.11%

This is an even grained silica sand, containing a small proportion of yellowish clay particles. Probably indications of iron present. It should be useful for foundry purposes as a "core" sand, having a small proportion of natural binder.

PITTSBURGH LOAM **VIBRATORY TEST**
Cheswick, Allegheny County, Pa.

This is an extremely heavy bonded sand, containing a well-balanced proportion of silica sand, well sprinkled with crushed rock gravel of quartz and flint. There is no lime present.

This is an excellent material for heavy loam work or cast steel and should give a good finish to heavy castings and stand hard usage.

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RHODE ISLAND

There are no known deposits of molding sands in the State of Rhode Island.

FINE CORE SAND
Providence, R. I.

A very fine irregular grained silica sand, probably a wind-blown deposit sample was submitted. This sand could be used for light core work but has no bond content. It shows about 5% of very fine silt, which passes through 150-mesh sieve.

This is the only specimen obtained from Rhode Island.

SOUTH CAROLINA

U. S. Geological Survey Bulletin 624 of 1917, gives molding sand in two places only, i. e., *Columbia,* Richland County, and *Charleston,* Charleston County.

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SOUTH DAKOTA

No molding sands have been found in this State.

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TENNESSEE

There are numerous deposits of molding sands in Tennessee, some of which are excellent for general jobbing purposes, but there is no particularly established grade. The general predominance of silt in the heavy grained red sands is objectionable and the extreme fineness of the yellow fine sands of Benton, Madison, Carroll and Henry Counties and the irregularities of the deposits, make it hard to obtain uniformity of grades.

Some grades are mined in Davidson, Franklin, Hamilton, Hardeman, Knox, Louden and Rhea Counties.

There is a good field here for the marketing of sands of the Ohio Valley and Kentucky sands.

NO. 2 BLOOMINGTON SPRINGS

Putnam County VIBRATORY TEST

Bond, 59%; Silica, 41%

This is an extremely fine sand with an excessively high bond content. It is too fine and strong for cast iron, but it would make an excellent strengthener for fine brass molding sands. Great care must be used to avoid excess bond in the heap.

Vibratory Test
Tennessee Red Bond, 29.5%; Silica, 70.5%
Saulsbury, Hardeman County

This is a medium fine grained sand with a very strong bond, suitable for general bench and machine molding. It is mined in the southwestern part of the State, not far from Memphis.

Jackson Red (Ungraded) Vibratory Test
Jackson, Madison County Bond, 40%; Silica, 60%

This is a very heavy dark red sand, which would be useful for general jobbing foundry purposes. In the specimen tested there is a very pronounced band of silt—Ferric Oxide.

The sands from Henry, Benton and Carroll counties, range in every grade and shade conceivable. Some of them would be the most wonderful in the country if they could only be mined separably. Seven specimens from Hollow Rock Junction, Sawyers Mills and Zack districts show as follows:

1. Dark red, fine grain strong—no mica.
2. Light red, fine grain, weak—mica schist plentiful —silty.
3. Pink, medium grain, weak—trace—clean.
4. Yellow—extremely fine, strong—trace—clean.
5. Light brown, extremely fine—weak—plentiful—silty.

6. Lavender—extremely fine—weak—plentiful—silty.
7. Light gray—extremely fine—weak—plentiful—silty.

The sands mined in this district are in scattered deposits and the various kinds as shown above become unavoidably mixed which makes it extremely hard for the shipper to guarantee any certain grade, even if he so wished.

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VIRGINIA

U. S. Bulletin No. 624 gives molding sands dug in the vicinity of Fredericksburg, Petersburg and Richmond.

NO. XXXX MOLDING SAND

Appomattox, Appomattox County

VIBRATORY TEST

Bond, 40.0%; Silica, 60.0%

This is a splendid grade of light yellow sand, medium fine grain of very even texture. The sample shows no silt or lime. It is very open and suitable for all forms of light castiron and should provide an excellent finish to the castings.

This would be an excellent sand for enamelware castings, hardware castings and aluminum. The bond is fairly strong. Excess usage should be avoided. It should wear well.

Vibratory Test

Dixie Sand Bond, 44.5%; Silica, 55.5%

Appomattox, Appomattox County

This is an extremely heavy grained strong bond sand, suitable for dry sand molding, steel and heavy floor work. It is very strong in bond and has no lime. It should wear well. There is a slight trace of silt, but not enough to affect the molding or castings.

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WEST VIRGINIA

U. S. Bulletin No. 624 shows molding sands mined in Cabell County at Huntington and Star City, Monongalia County.

No specimens of these sands have been obtained.

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WYOMING

No molding sands have been reported from this State.

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WISCONSIN

The State Geological and Natural History Survey of Wisconsin (W. O. Hotchkiss, Director), have made some studies of the molding sands of the State and reports have been prepared on some of the sands by Heinrich Ries and F. L. Gallup, showing a number of microphotographs of both molding and core-sands, also comparative tests of refractoriness, including a number of sands from other States. This research has not yet been completed.

Molding sands have been produced in about twelve different localities, mainly in the southern half of the State. There would probably have been a greater development in the past, if it were not for the close proximity of the foundry towns to the Illinois molding sand districts.

Wisconsin sands do not run high in bonds and several of the deposits are equal to any in the country in texture. The core-sands of the Berlin district are excellent and very uniform in grain size. The sands of the Rock River Valley being higher in bond are more suited for general molding purposes.

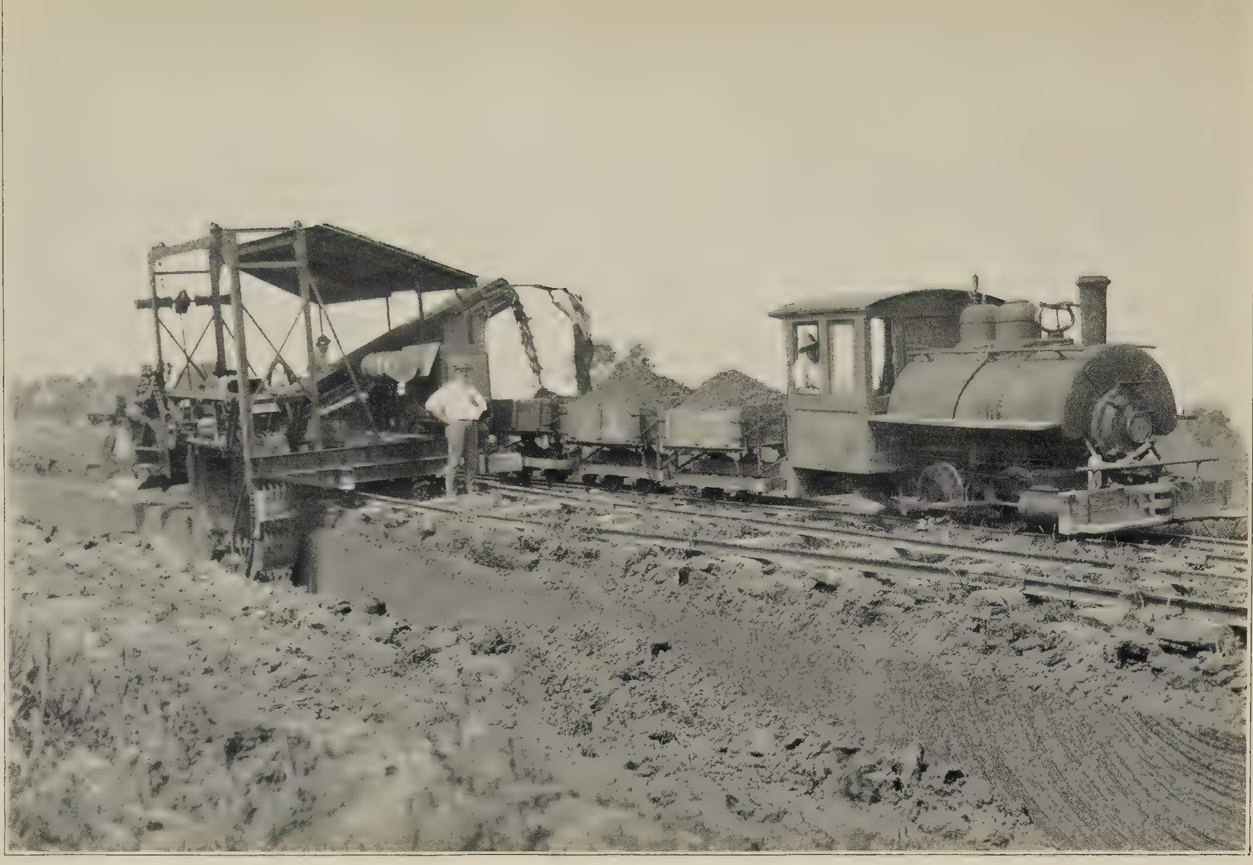
VIBRATORY TEST

NO. 1 ALUMINUM Bond, 39.39%; Silica, 60.60%
Ableman-Sauk County
Baraboo River District

This is an extremely fine, open grain strong bond sand, suitable for non-ferrous metals only. It is light yellow in color.

SILVERTON SAND
Wheatland, Kenosha County VIBRATORY TEST
Fox River District Bond, 40%; Silica, 60%

A strong, heavy open grained sand, very useful for floor work, heavy machinery, etc., and general jobbing. It is dark yellow in color and has a very low lime content. It should not be added to the heap



Wisconsin Sand—Showing Mechanical Loader

in large quantities and excessive moisture must be avoided. It should wear well.

NO. 2 BELOIT SAND
Beloit, Rock County — VIBRATORY TEST
Rock River District — Bond, 50%; Silica, 50%

This is a fairly good sand for general jobbing, bench and machine, also light floor work and agricultural work, etc. It weakens easily if excess core-sand is dropped into the heap, or if excess sea-coal is used. It is well to have a strong bond sand for renewal purposes. The finish of the castings is all that could be desired from this sand on all ordinary work. There is a plentiful supply of this sand in the vicinity of Beloit. The vein from which this specimen was taken is from 3 to 4 ft. deep, with about 1 ft. of the top soil. Below this is a heavy clay. The lime content in this sand is low and it is light brown in color.

NO. 0 JANESVILLE — Bond, 53.86%; Silica, 41.14%
VIBRATORY TEST
Janesville, Rock County — Silt, 15.38%
Rock River District

This is a very heavy bonded sand of medium grain. It is useful for heavy bench molding and light machinery or agricultural floor work. This sand would work well in combination with a more open sand.

It is very useful where the sand is subjected to heavy hard usage, and should also prove useful as a strengthener where the sand has been weakened by excess core droppage. It should not be used alone on light work and excess moisture must be avoided. This sand, although suited to all general lines of work, should not be used alone where air, gas or pressure tests are required on account of silt present. A little care in selecting from the run of the pit might avoid this condition.

NO. 1 JANESVILLE

Janesville, Rock County VIBRATORY TEST
Rock River District Bond, 60.66%; Silica, 39.33%
Silt, 9.63%

This is a very heavy bonded sand, with medium heavy grain, useful for heavy bench molding, light machinery, floor work, etc. The high bond in this sand makes it useful as a strengthener for weak sands. If used alone, it can only be added to the heap in small quantities at any time. The silt present is not enough to be harmful.

NO. 2 JANESVILLE

Janesville, Rock County VIBRATORY TEST
Rock River District Bond, 72.0%; Silica, 28.0%
Silt, 5%

This is an extremely strong bonded sand, medium fine grain, only suitable for light machine and bench work and should be used in connection with a more open grained sand. It would be a very useful sand as a strengthener of weaker sands or wherever a binder is needed. If used alone, it will not stand hard ramming or pressing and excess moisture must be avoided.

Berlin Sand

Berlin, Greenlake County Vibratory Test
Fox River District Bond, 30.0%; Silica, 70.0%

This is a splendid specimen of fine molding sand, suitable for very light hardware, etc. It has an unusually even structure and will stand hard ramming or pressures. If properly tempered it should give an excellent finish to work requiring plating. For brass or aluminum this should prove an excellent sand although it would weaken easily if used on heavier grades of work.

Several prepared or blended sands were submitted as molding sands from Greenlake County, and are given for comparative purposes. The trade symbols have been left out and the specimens classed A, B, C, etc.

Vibratory Test
A—Greenlake County Bond, 33%; Silica, 45%
Silt, 19%

This is a medium fine sand (blended), which would appear suitable for light hardware, were it not for the unusual condition of that division classed as bond, which appears to be simply a combination of the finer silts without any semblance of viscosity. In the specimen tested the bond portion remained practically in suspension over a week.

VIBRATORY TEST
B—Greenlake County Bond, 52%; Silica, 48%

The bond in this specimen is entirely out of proportion to the silica for so fine grained sand and could only be used as a strengthener for some other fine sand. In the present shape it is not suitable for any form of castiron molding.

VIBRATORY TEST
C—Greenlake County Bond, 54%; Silica, 46%

This is an extremely fine sand, not suited for any form of castiron molding. Although the bond shows very high, the grain is very uneven in the specimen tested. The bond blending off into a silt-like condition would surely cause trouble in castiron.

D—Greenlake County VIBRATORY TEST
MOLDING SAND (Blended) Bond, 14%; Silica, 85%

This is a fine grained sand, with a very even grain and a low bond content. This would prove a better core-sand than a molding sand. It would make an excellent opener for fine sands having excess bond.

BERLIN NO. 1 CORE-SAND
Berlin, Greenlake County VIBRATORY TEST
Fox River District Bond, 9%; Silica, 91%

This is an excellent core-sand with a very even texture and with just sufficient natural bond to give excellent results in all classes of stand-up cores, light work, etc.

It is very open and will give an excellent finish to the interior of the castings, at the same time providing a free escape for the gases. This sand should free itself readily from the castings.

NOTE: The foregoing specimens (those classed as A, B, C, etc.), show the erratic manner in which otherwise first class sands are blended, without a suitable plan of examination of the various grades before mixing. Here is an ideal application of the Vibratory Test in the blending of sands by the Producer to suit the individual requirements of the foundryman.

FOREIGN AND MISCELLANEOUS SANDS AND CLAYS OF INTEREST

VIBRATORY TEST

NO. 2 CANTERBURY Bond, 19.0%; Silica, 81.0%
Sydney, New South Wales, Australia

This is an unusually even textured sand, very open and medium fine in grain. It is low in bond. This sand would be excellent for all classes of radiator or pocket work and should give excellent finish to the castings. A stronger bond sand is needed to replace that which burns out or is weakened by core droppings.

This sand will stand extremely hard ramming or pressures. It is similar to our Wanetah, Indiana, or Hamilton, Ontario, Canadian sands and can be used for all grades of bench work and aluminum.

VIBRATORY TEST

NO. 1 GOULBURN Bond, 25.0%; Silica, 75.0%
Sydney, New South Wales, Australia

This is an extremely fine sand of very even texture. It is an excellent sand for brass and non-ferrous metals and can be used for light hardware where plating is required and will give excellent finish to the castings. Care must be taken to avoid excess moisture or hard ramming if used for iron. It is RED in color.

NO. 3 GROUND SILICA ROCK — VIBRATORY TEST
Bond, 21.0%; Silica, 79.0%
Sydney, New South Wales, Australia

As its name implies this is a prepared material, ground from rock which shows a good bond content. This should prove an excellent material for steel molding and should provide an excellent finish to the castings. For dry sand molds in castiron heavy work, it should be blended with a strong bonded sand and prepared in a pan mill or mixer—in fact, clay is needed. It is grey in color. The exact location of these sand pits were not given.

VIBRATORY TEST
BELGIUM* — Bond, 28.0%; Silica, 72.0%
Band of Silt, 2%

This specimen has every appearance of Millville sands (New Jersey) and is yellow in color. There is a small dark band of silty material—a very pronounced mixture of micaceous and igneous rock, about 2%, but this is not harmful.

This sand is suitable for all grades of light castiron bench and machine molding. It is of even texture, medium fine grain and a high heat resistant. It should be excellent for aluminum. It is very open and should wear well.

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*(Specimen taken from shipment to Los Angeles Foundry.)

CANADA

STONY FIELD CREEK — VIBRATORY TEST

Hamilton, Ontario, — Bond, 24.0%; Silica, 76.0%
Canada

This is one of the best bonded molding sands yet received from Canada. It is a splendid sand for any class of work which requires heavy ramming—radiator work or auto cylinder work. It is very even, open grained sand and should give an excellent finish to the castings. It will weaken under hard usage and a binder should always be at hand.

It is dark red in color, the silica portion being sprinkled with black.

VIBRATORY TEST

NIAGARA SAND — Bond, 16.66%; Silica, 83.33%

Hamilton, Ontario,
Canada

This is an extremely open red sand, similar to the Wanetah sands of Indiana in all respects. It is a very useful sand for radiator work and similar castings which require hard ramming and pressures and still allowing free escape of the gases from the mold.

It is a splendid opener for facings and very useful in deep pocket work. It would weaken very easily when used alone for heavier lines of work and a stronger bond sand should always be at hand to strengthen the heaps when needed.

Brockville Sands	Vibratory Test
No. 1	Bond, 4.22%; Silica, 95.77%
No. 2	Bond, 4.76%; Silica, 95.23%

These sands were submitted as molding sands, but there is no conceivable way they could be used outside of dry sand molding, with an artificial binder, having no bond of their own. These sands would be more useful as core-sands, or would make good openers for strong clay-bonded sands.

Vibratory Test
Canadian Pipe Sand — Bond, 15%; Silica, 85%
Niagara Falls, Ontario District

As its name implies this is a heavy grained, low bonded sand of very even texture. It is a sand which will stand extremely hard ramming and provide a free vent to the gases. Blended with a similar sand with a stronger bond it would be useful for all grades of heavy machinery castings, but if used alone, it would weaken easily.

Vibratory Test
No. 2 Sand — Bond, 12%; Silica, 88%
Niagara Falls, Ontario District

This is a very even grained, low bonded sand, medium fine texture. It is an excellent sand for blending purposes with stronger bond sands of the same type. It should provide an excellent finish to the castings, but extra bond must be provided.

VIBRATORY TEST
NO. 3 SAND Bond, 25%; Silica, 75%
Niagara Falls, Ontario District

All three of these sands from the Niagara Falls, Ontario District, are dark red in color and similar to the Wanetah sands of Indiana and of about the same general character.

VIBRATORY TEST
LAURENTIAN SAND Bond, 17.0%; Silica, 83.0%
Laurentian Mountain, District Quebec

The specimen of this sand which the author obtained at Montreal was too small for testing purposes. The sand appears to have very little bond, is very fine in grain and strongly impregnated with mica schist. It would require a strong bond for blending, similar to our Tennessee sands.

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FRANCE

FRENCH MOLDING VIBRATORY TEST
SAND (Unprepared) Bond, 58.33%; Silica, 41.66%

This is an extremely fine even grained sand with an unusually high bond for so fine a sand. This sand is generally prepared to suit the class of castings required. In its natural state the bond is too high and would give far better results if blended with a fine open sand. It is generally used in casting ornamental bronze and brass art work, and is also used considerably in the casting of gold and silver. Its fineness insures accuracy of detail.

Windsor Lock (Connecticut) and Trussville No. 1 (Alabama) both are suitable sands as openers for some grades of jewelry castings.

LIME IN MOLDING SAND

There are many conflicting opinions as to the action of lime in molding sand which comes in contact with molten metal and its effects upon the castings.

In the use of heavy grained sands of gravel-like structure for very heavy machinery castings, small particles of limestone gravel will explode and embed themselves in the molten metal, pitting the casting.

When a strong clay bond is used for strengthening purposes, lime is not necessarily harmful up to six per cent. A sand of this type would be added to the heaps in approximately one part new sand and two hundred parts heap sand. This brings the percentage of lime in the heap very low. However, in the new state it is extremely difficult to handle due to the heavy hard clay lumps which are formed when dry.

When general sands are high in lime the effect can be seen in the cleaning of the castings. It will be found that on heavier sections of metal and in corners the sand is fused to the castings. The low fusion point of the lime serves as a flux between the silica grains and the molten metal.

Cores made of sand containing lime will also fuse to the metal and give considerable trouble in tumbling.

The presence of lime in a sand may be very easily detected with muriatic acid. A lime-free sand will absorb a few drops of muriatic acid quietly, whereas a sand containing lime will foam under muriatic acid. The amount of lime may be approximated by observing the amount of foaming caused by a few drops of acid.

IN CONCLUSION:

The descriptions given are only of the specimens as tested and do not necessarily describe the run of the pits.

The opinions given are only as they appeared to the author upon examination by the Vibratory Test.

The author has tried to avoid all references which might prove offensive to personal or commercial interests.

Where references are made to the sands of any State and not credited, they have been obtained from either U. S. Bulletin No. 624, USEFUL MINERALS OF THE UNITED STATES, 1917 or various State Geological Reports.

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